PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION

Engineering Library GENERAL LIBRARY JUL 9 1920 UNIV. OF MICH.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2

VOL. CIX.—No. 2843.] *LONDON: FRIDAY, JUNE 25, 1920.* [*Registered at the General Post Office as a Newspaper.*] [PRICE... 1s. 2d. BY FOREIGN POST ... 1s. 6d.

Rubber MANUFACTURERS
Packings "Redstone" "Bluestone"
GUTTA PERCHA & RUBBER, LIMITED.,
Toronto - - Canada. 8510

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches, BOILER FEED PUMPS.
See Advertisement, pages 33 and 96, last week.
PATENT WATER-TUBE BOILERS, AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

John H. Wilson & Co., Ltd.
Birkenhead.
See Illustrated Advertisement Page 125, June 18.

Locomotive Shunting Cranes
Steam and Electric Cranes,
EXCAVATORS, CRANE-NAVVIES, GRABS, CONCRETE-MIXERS, SHIPS WINDLASSES, WINCHES, and DECK MACHINERY. 8569
LISTS OF STANDARD SIZES ON APPLICATION.
London Office: 15, VICTORIA STREET, S.W. 1.

Craig & Donald Ltd., Machine TOOL MAKERS, JOHNSTONE, near Glasgow.
For class of Machine Tools see our Illustrated Advertisement every alternate week. 1358

CHANTIERS & ATHLIERS
Augustin - Normand
67, rue de Perrey—LE HAVRE (France). 3890
Destroyers, Torpedo Boats, Yachts and Fast Boats, Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Electric Lifts (UP TO 35 TONS.) 8143
S. H. HEYWOOD & CO., LTD., RHODISH.

Steam Hammers (with or without guides). Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS. 8322
DAVIS & PRIMROSE, LIMITED, LEITH, EDINBURGH.

Brett's Patent Lifter Co. LIMITED.
Hammers, Presses, Furnaces, COVENTRY. 610

Bever, Dorling & Co., Ltd., BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1890

Cranes.—Electric, Steam, HYDRAULIC and HAND, of all types and sizes.
GEORGE RUSSELL & CO., LTD., Motherwell, near Glasgow. 8207

Telegrams—"Cylinders," Birmingham.
Weldless-Steel Tubes for Water-tube Boilers, Superheaters, Shafting, Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. 8179

Yarrow & Co., Ltd., SHIPBUILDERS AND ENGINEERS, GLASGOW.
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF EXCEPTIONAL SHALLOW DRAUGHT.
Repairs on Pacific Coast by YARROWS, LIMITED, Victoria, British Columbia. 7766
SHIPBUILDERS, SHIP REPAIRERS AND ENGINEERS.

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

Yachts, Launches or Barges Built complete with Steam, Oil or Petrol Motors; or Machinery supplied. Oct 3551
VOSPER & CO., LTD., BROAD STREET, PORTSMOUTH.

Cochran MULTITUBULAR AND CROSS-TUBE TYPES. **Boilers.**
See page 17, June 18. 8305

Electric Cranes. 8143
S. H. HEYWOOD & CO., LTD., RHODISH.

FOR
Drop Forgings write
GARTSHERRIE ENGINEERING & FORGE CO., 50, Wellington Street, Glasgow. 7896

Gauges FROM **Stock.**
THE
Newall Engineering Co. (Proprietors, Peter Hooker, Ltd.), LONDON, E. 17. 7824

Tank Locomotives Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO., LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 8203

Excavators.
FROM 50 TO 600 YARDS PER HOUR.
D. Whitaker, 7985
1, UNION STREET, LINCHESTER.

"**Spencer Hopwood**" Patent
Sole Makers: **Boilers.**
W. H. SPENCER & CO., HITCHIN, HERTS.
See page 15, June 18.

The Cambridge and Paul Instrument Co., Ltd.,
Manufacturers of Mechanical and Electrical Instruments of Precision.
WORKS: Cambridge and New Southgate, London, N. 11. 8194
GOLD MEDAL-LIVERPOOL EXHIBITION-AWARDED.
Duckham's Patent Suspended WEIGHING MACHINES.—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD. LONDON, E.—Hydraulic Cranes, Grain Elevators, &c.
See Illus. Advt. last week, page 15. 7977

FOR
Railway Wagon Couplings and GENERAL SMITHY WORK, write
WELDLESS CHAINS, LTD., Coatbridge. 8184

Iron and Steel
Tubes and Fittings. 8930
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement page 107.

Royles Limited, ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, } Row's PATENTS.
CONDENSERS, AIR HEATERS, Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 8722

Tubes and Fittings, IRON AND STEEL.
Stewarts and Lloyd's, Ltd.,
41, OSWALD ST., GLASGOW.
BROAD STREET CHAMBERS, BIRMINGHAM; and LONDON OFFICE—
WINCHESTER HOUSE, OLD BROAD STREET, E.C.
LONDON WAREHOUSE—167, UPR. THAMES ST., E.C.
LIVERPOOL WAREHOUSE—53, PARADISE ST.
MANCHESTER WAREHOUSE—34, DEANSGATE.
CARDIFF WAREHOUSE—132, BUTE ST.
BIRMINGHAM WAREHOUSES—NILE STREET, SHEEPSCOTE STREET.
See Advertisement page 28. 8167

Die Finished Castings ensure rapid production and reduce prime cost by eliminating machining operations. Write for illustrations to SPARKLETS AND GENERAL Mfg. Co., Ltd., Edmonton, London, N. 18. 7995

"**Petrolex**" **Fire Extincteur** puts out flaming motor spirit, burning oil, electric arcs and every kind of fire.—BRITISH FIRE APPLIANCES Co., Ltd., 109, Victoria St., London, S.W. 1.

Locomotive Traversers (ELECTRIC). 8143
S. H. HEYWOOD & CO., LTD., RHODISH.

Union Transit Company,
FREIGHT CONTRACTORS.
SHIPPING AGENTS.
INSURANCE BROKERS.
WAREHOUSE KEEPERS and DISTRIBUTING AGENTS.
We solicit a trial shipment. 8089
Chief Office: 381, ARGYLE STREET GLASGOW
Cables and Telegrams: "Transit, Glasgow."

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 8331

See's Patent Hydro-Pneumatic **Ash Ejector.**
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, P. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Oct 4535

Diesel Driven Generators,
400-500 Kw., D.C., 500 or 250 Volts, 320 R.P.M., in excellent condition. Low price.
Engines and Dynamos could be sold separately.
Also TWO 500 Kw. Parsons TURBINES, 230-250 Volts, D.C. (in series 460-500 volts), complete with Spare Armature and Condenser.
Exhaust TURBINE SET, Willans-H.C.C., 200 Kw., 440/500 Volts. Complete with Condenser, Pumps, &c.
JENNINGS, West Walls, Newcastle-on-Tyne. 7069

For Sale.— MOTOR-DRIVEN PLANING MACHINE,
To plane 20 ft. by 20 ft. by 10 ft., four Tool Boxes. Condition as new. Makers, Buckton & Co. Price and particulars from—
MURRAY, McVINNIE & CO., LTD., Mavisbank Quay, Glasgow. 7819

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported Upon. Over 25 years' experience. Tel.: 736 and 737 Stratford. Wire: "Rapidising, London." —Great Eastern Road, Stratford, E. 15. 1794

P. & W. MacLellan, Limited, CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 139, Trongate, GLASGOW. Oct 8647
Registered Offices: 106a, Cannon St., London, E.C.

Yarrow Patent Water-Tube Boilers. 7769
MESSRS. YARROW & CO., UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO., LTD., SCOTSTOUN, GLASGOW.

John Bellamy Limited, MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1914
Boilers, Tanks & Mooring Buoys STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.
RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd. THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Oct 3363

Head, Wrightson & Co., LIMITED.
See Advertisement page 99, June 18. 3402

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C.3
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice Making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c. &c. 7139

Steel Castings.
THOMAS SUMMERSON & SONS, LTD., DARLINGTON. 7969

Electric Transporters.
S. H. HEYWOOD & CO., LTD., RHODISH. 8143

Aluminium Is the Conductor On the Longest Transmission Systems. 8291
THE BRITISH ALUMINIUM CO., LTD., 109, Queen Victoria St., London, E.C. 4.

Centrifugals.
Pott, Cassels & Williamson, MOTHERWELL, SCOTLAND. 7941
See half-page Advertisement page 55, June 11.

See Advt. Page 134, June 18. **Steam Hammers, Power Hammers, Steam and Friction Drop Stamps.**
B. & S. Massey, Ltd., 8233 MANCHESTER.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 8443

Glamorgan County Council.

SUMMER MINING AND ENGINEERING SCHOOL, 1920.
SOUTH WALES COALFIELD.

This Summer School will be held from July 26th to August 14th at the University College, Cardiff, and the Boys' County School, Penarth, Courses being provided as follows:—

Mining Engineering, Mechanical and Electrical Engineering, and Special Science Course for Teachers (Chemistry, Physics and Geology). The work in each Course will be mainly practical. A Surveying Course, Outdoor and Field Work, to meet the requirements of all grades of students will be held. Suitable "Intensive and Refresher" Courses in all subjects for Demobilised Officers and other Ranks, and a Special Course conducted by specialists in Economics, Civics and Industrial History will also be held. Full particulars, Prospectus and Form of Application may be obtained on receipt of a stamped addressed foolscap envelope from the CHIEF EDUCATION OFFICIAL, Glamorgan County Hall, Cardiff. H 375

Inst. C.E. Exams.—Over 300

successes by Correspondence Coaching. Several prizes. Sec. "O" now prepared. (Designs, Specifications and Quantities). A few vacancies open.—Address, 7434, Offices of ENGINEERING. 8438

Correspondence Courses for

B.Sc., Inst. C.E., I. Mech. E., all ENGINEERING EXAMS. Special Courses and Single Subjects. Personal tuition.—For full particulars apply to Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), Assoc.M.Inst.C.E., M.R.S.I., etc., 5–15, Trafford Chambers, 55, South John Street, Liverpool 8439

Inst. C.E., I. Mech. E., B.Sc.,

and all Engineering Examinations.—Mr. G. P. KNOWLES, B.Sc., Assoc. M. Inst. C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Hundreds of successes. Courses may commence at any time.—39, Victoria St., Westminster, S.W. 8839

A.M.I.C.E. and A.M.I.M.E.

Tuition. Also Postal Courses in Mechanical Engineering, Aircraft Design and Mathematics.—PENNINGTONS, 364, Oxford Road, Manchester.

TENDERS.

THE SECRETARY OF STATE FOR INDIA IN COUNCIL is prepared to receive

Tenders from such Persons as may be WILLING to SUPPLY BRIDGEWORK (100 ft. and 90 ft. spans).

The Conditions of Contract may be obtained on application to the DIRECTOR-GENERAL OF STORES, India Office, Whitehall, S.W. 1, and Tenders are to be delivered at that Office by Two o'clock p.m., on Tuesday, the 13th July, 1920, after which time no Tender will be received.

J. STEVENENS,
Acting Director-General of Stores.

India Office,
Whitehall, S.W. 1.
23rd June, 1920. H 313

COMMISSIONERS OF IRISH LIGHTS.

LIGHTSHIP "PETREL" FOR SALE.

The Commissioners of Irish Lights are prepared to receive

Tenders for the Purchase of

the above-named Wooden Light-Vessel, together with such of her Gear and Fittings as are now on board.

The "Petrel" was built in 1854, of oak framing, with elm, oak, and teak planking, fastened with copper and metal bolts. The bottom was sheathed with pitch pine, fastened with muntz-metal bolts, in 1896. Dimensions about 89 feet by 21 feet by 10 feet 10 inches depth of hold.

Applications to inspect the vessel at her moorings in Kingstown Harbour, Co. Dublin, should be made to the undersigned, from whom inventory and full particulars can be obtained.

Offers, sealed and endorsed "Tender for Petrel," must be posted in time to reach this office on or before Thursday, the 8th July, 1920.

By Order,
R. G. COOK,
Secretary.

Irish Lights Office,
D'Olier Street,
Dublin.
18th June, 1920. H 279

RHYL URBAN DISTRICT COUNCIL.

PIPELAYING.

The Urban District Council of Rhyl are prepared to receive

Tenders for the Laying of

certain CAST-IRON PIPES (principally 9 inch) and ancillary works in the Parish of Rhyl for a distance of about three miles.

Drawings may be seen and Specifications and Schedules of Quantities obtained on and after the 25th June, 1920, on application to the office of the Engineers, Sir ALEX. BINNIE SON & DEACON, 39, Buckingham Gate, Westminster, S.W. 1, or at my office in Rhyl, on deposit of a cheque for £3 3s. made out to me, which will be returned on receipt of a bona fide tender.

Sealed Tenders endorsed "Tender for laying Cast-iron Pipes, etc." are to be delivered at my office before noon on Friday, the 16th July, 1920. Tenders will only be accepted from persons with pipe laying experience.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES,
Clerk to the Council.

District Council Office,
Rhyl. H 286

RHYL URBAN DISTRICT COUNCIL.

CAST IRON PIPES, &c.

The Urban District Council of Rhyl are prepared to receive

Tenders for the Supply and

DELIVERY of about 400 tons of CAST IRON PIPES (principally 9 inch).

Specifications and Schedules of Quantities may be obtained on and after the 25th June, 1920, on application to the office of the Engineers, Sir ALEX. BINNIE SON & DEACON, 39, Buckingham Gate, Westminster, S.W. 1, on deposit of a cheque for £3 3s. made out to me, which will be returned on receipt of a bona fide Tender.

Sealed Tenders endorsed "Tender for Cast Iron Pipes" are to be delivered at my office before noon on Friday, the 16th July, 1920.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES,
Clerk to the Council.

District Council Offices,
Rhyl. H 290

THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of the

following stores, namely:—

	Fee for Specifications.
1. Mantles for Lamps.	2/6
2. Linoleum.	7/6
3. Ropes, Twines, &c.	10/-
4. White Lead.	£1
5. Galvanised Stamped Steel Mortar Fans.	5/-
6. Canvasses, &c.	10/-

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned.

The fee should accompany any application by post.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Mantles for Lamps," or, as the case may be, not later than Eleven o'clock a.m., on Tuesday, 6th July, 1920.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
43, Copthall Avenue, E.C. 2.
London, 23rd June, 1920. H 404

SALE BY TENDER.

To Engineering Concerns desirous of acquiring a New Works with fully equipped New Plant in Manchester.

Re MESSRS. NEWTON-HARPER, under Dissolution of Partnership.

MOTOR CAR ENGINEERING WORKS known as VICTORY WORKS, STRETFORD, MANCHESTER.

To be Sold by Tender, the

above-mentioned recently erected and well-equipped MOTOR CAR ENGINEERING WORKS, with the business and Goodwill thereof, as a going concern, situate at and called "Victory Works," in Stretford, Manchester, and now carried on by the firm of Messrs. Newton-Harper, who are dissolving partnership.

The Works were erected in 1919 and are situate within 3½ miles of the centre of the City of Manchester, on the Chester Road Main Car Route and within a short distance of Stretford and Old Trafford Railway Stations.

The Site contains an area of 14,480 square yards, including street land, and is held on a Lease for 999 years from the Trustees of the Trafford Estate at a yearly rental of £163 7s. 6d. and subject to the usual covenants contained in Leases of the Trafford Estate.

The Buildings are extensive and planned on the most modern lines. All the Machinery and Plant is of the most modern description, while the Electrical power and Lighting installations are of the latest and most approved type.

The Stock in Trade of raw material and finished and unfinished goods will be taken over at a valuation by the purchaser.

In addition the whole of the Patent Rights appertaining to the 12 HP. Newton Chassis (excluding the Italian Rights), and the Drawings and Specifications in connection therewith will be sold with the business.

The above is offered for sale in two separate lots, namely:—

LOT 1, which comprises the Motor Car Engineering Works and the site thereof as aforesaid and all the machinery and fixed and Loose Plant used in connection therewith and the Stock in Trade, the Patent rights of the Newton Chassis, and the Goodwill of the business (except the Goodwill and Stock in Trade attached to Lot 2) as a going concern with the benefit of all pending contracts.

LOT 2. The Goodwill in connection with the specialised manufacture of Branches for Engineering Works which is now carried on by the firm as a separate Branch of the business and the whole of the Drawings and the benefit of all pending contracts in connection therewith and all the Stock of special steel used in this Department. No Tools or Machinery are included in this Lot.

The name Newton-Harper is excluded from the sale and the Purchaser shall have no right to use such name nor either of such names. Detailed Particulars of the Property and Inventories of the Machinery, Plant, &c., to be sold together with Conditions of Sale and Form of Tender attached, have been printed and may be had on application to any of the undersigned.

Tenders on the Form supplied must be sent in on or before the 1st July, 1920, addressed to FRANK DOWLER, Esq., Chartered Accountant, 8, King Street, Manchester.

All further information that may be desired and orders to view may be obtained from the above named.

FRANK DOWLER, Esq., the Receiver appointed by the Partners,
F. S. AIREY, ENTWISTLE & CO., Auctioneers and Valuers, 10, Norfolk Street, Manchester, or
F. O. S. LEAK & PRATT, Solicitors, 6, John Dalton Street, Manchester. H 120

Tenders are Invited for the

REMOVAL and PURCHASE of TWO BADCOCK & WILCOX STEAM BOILERS with all Mountings and Fittings, Feed Pumps, Mechanical Stokers, and Forced Draught Electric Fan Equipment, together with their Brickwork Settings. Evaporation of each boiler approximately 6000 lbs. steam per hour at 100 lbs.—For full particulars reply BOX 35, care of MATHER & CROWTHER, LTD., 10, New Bridge Street, E.C. 4. H 415

AUCKLAND HARBOUR BOARD. NEW ZEALAND.

Tenders are Invited for the

SUPPLY of ONE Two Ton TRUCK CRANE. Specifications can be obtained on payment of a deposit of Two Guineas, at the office of the Board's Agents, Messrs. W. & A. McARTHUR, LTD., 18/19, Silk Street, Cripplegate, London, E.C. 2.

Tenders to reach Messrs. W. & A. McARTHUR, LTD., not later than 31st July, 1920. G 775

THE CROWN AGENTS FOR THE COLONIES, acting on behalf of the GOVERNMENT OF NIGERIA, will be inviting

Tenders in the near

future for the SUPPLY, ERECTION and EQUIPMENT of new LOCOMOTIVE and CARRIAGE WORKSHOPS for the NIGERIAN GOVERNMENT RAILWAYS, at Ebute Metta, near Lagos, in Nigeria, consisting of Locomotive Shops 500 ft. by 235 ft., and Carriage Shops 450 ft. by 220 ft., both of steel construction.

Firms who wish to tender for the work are requested to furnish the Crown Agents with particulars of similar work carried out by them in recent years, quoting as reference number B.371/7. They should state whether they are willing to send a representative to Lagos to ascertain the conditions of labour, etc., in Nigeria. The Crown Agents reserve to themselves the absolute right to determine which firms shall subsequently be invited to submit Tenders.

4, Millbank,
London, S.W. 1. H 308

RHYL URBAN DISTRICT COUNCIL.

SLUICE VALVES, &c.

The Urban District Council of Rhyl are prepared to receive

Tenders for the Supply and

DELIVERY of SIX SLUICE VALVES of 9 in. and smaller sizes, together with AIR VALVES and SURFACE BOXES.

Specifications and Schedules of Quantities may be obtained on and after the 25th June, 1920, on applications to the office of the Engineers, Sir ALEX. BINNIE SON & DEACON, 39, Buckingham Gate, Westminster, S.W. 1, on deposit of a cheque for £2 2s. made out to me, which will be returned on receipt of a bona fide Tender.

Sealed Tenders endorsed "Tender for Valves, &c.," are to be delivered at my office before noon, on Friday, the 16th July, 1920.

The Council do not bind themselves to accept the lowest or any Tender, or to defray any expenses in connection with tendering.

Dated this 25th day of June, 1920.

THO. HUGHES.
Clerk to the Council.

District Council Offices,
Rhyl. H 289

APPOINTMENTS OPEN.

University of Bristol.—

ASSISTANT LECTURER IN ENGINEERING. £350—£10—£400. For particulars and form of Application send at once stamped, addressed, foolscap envelope, to the REGISTRAR of the Merchant Venturers' Technical College. H 319

The Royal Technical College,

Glasgow, Department of Mechanical Engineering.—Several JUNIOR ASSISTANTS are REQUIRED, mainly to give instruction in Drawing and in the Laboratories. Duties to commence 1st September. Salaries from £230 per annum according to training and experience.—Applications should be addressed to the PROFESSOR of MECHANICAL ENGINEERING, THE ROYAL TECHNICAL COLLEGE, Glasgow. H 305

CITY OF BIRMINGHAM EDUCATION COMMITTEE.

Required in September next,

the full time SERVICES of LECTURERS in the following subjects:—

MUNICIPAL TECHNICAL SCHOOL
(Principal—W. H. SUMPNER, D.Sc.).
Metallurgy, Physics, Electrical Engineering, Mechanical Engineering.

HANDSWORTH TECHNICAL SCHOOL
(Principal—W. H. HARRISON, A.R.C.Sc.),
Mechanical Engineering.

The commencing salary offered will depend upon the previous training and experience of the candidates.

For full particulars apply to SECRETARY, Municipal Technical School, Suffolk Street, Birmingham, specifying post in respect of which particulars are required. H 118

CITY OF CARDIFF EDUCATION COMMITTEE.

THE TECHNICAL COLLEGE.
Principal - CHARLES COLES, B.Sc. (Lond.).

The Services are Required of

an ASSISTANT LECTURER in the Engineering Department, whose duties will be concerned mainly with Laboratory work.

Commencing salary £330 per annum, rising by annual increments of £30 to £450 per annum.

Applicants should have had workshop training, teaching experience, and good experience in the Engineering Laboratory of a Technical College. He should be able to keep the equipment in good condition, and to help with the design and manufacture of additional apparatus.

Applications on foolscap paper, stating age, full qualifications, teaching and other experience, and giving copies of not more than three testimonials, should reach the Principal on or before Friday, July 2nd, 1920.

JOHN J. JACKSON, B.A.,
City Hall, Director of Education.
Cardiff. H 186

HUDDERSFIELD TECHNICAL COLLEGE.

Applications are Invited for

the position of ASSISTANT LECTURER IN ELECTRICAL ENGINEERING. Initial salary £260. Further particulars may be obtained on application to the Secretary, Technical College, Huddersfield. H 416

UNIVERSITY COLLEGE, NOTTINGHAM.

MINING DEPARTMENT.

Applications are Invited for

the POSITION OF LECTURER in Fuels and Oils, who will also be required to undertake lectures in general elementary chemistry, mine gases, explosions, gob fires, and coal carbonisation, to Mining Students. Salary £400.

Further particulars and forms of application, which must be returned by June 30th, may be obtained from the REGISTRAR. H 80

UNIVERSITY COLLEGE, NOTTINGHAM.

MINING DEPARTMENT.

Applications are Invited for

the POSITION OF LECTURER in Colliery Engineering, whose duties will involve lecturing to Mining Students on Mechanics, steam, compressed air and general power distribution. Preference will be given to candidates who have had practical experience in the manufacture and installation of colliery plant. Salary £400.

Further particulars and forms of application, which must be returned by June 30th, may be obtained from the REGISTRAR. H 79

CITY OF LINCOLN
MUNICIPAL TECHNICAL SCHOOL.

A. E. COLLIS, M.I.M.E., Principal.

Applications are Invited for

an ADDITIONAL LECTURER in the Mechanical Engineering Department.

Candidates will be required to take day and evening classes. University degree or equivalent qualification desirable.

Workshop and Drawing office training, teaching experience, and good experience in Engineering Laboratory essential.

Commencing salary £325, rising by annual increments of £12 10s. to £400.

Form of application and further particulars may be obtained from the Principal to whom applications should be returned not later than 5th July, 1920. H 353

WEST BROMWICH EDUCATION COMMITTEE.

MUNICIPAL SCIENCE AND TECHNICAL SCHOOL.

APPOINTMENT OF PRINCIPAL.

The Committee are proposing to re-organise the scheme of Science and Technical Education in the Borough, and invite

Applications for the Post of

PRINCIPAL of the Science and Technical School.

The salary offered is at the rate of £500 per annum, rising by annual increments of £50 to £700 per annum.

For Form of Application and further particulars apply to the undersigned.

ARTHUR LEWIS,
Director of Education.

Education Offices,
West Bromwich.
18th June, 1920. H 311

UNIVERSITY OF BIRMINGHAM.

FACULTY OF SCIENCE.

PROFESSORSHIP OF MINING.
(Mining and Petroleum Technology).

The Council of the University invites

Applications for the Chair

OF MINING, vacant by the resignation of Professor SIR JOHN CADMAN.

The stipend offered is £1250 a year.

Applications should be received by the undersigned on or before the 10th July, 1920.

Further particulars may be obtained from
GEO. H. MORLEY,
Secretary. H 110

UNIVERSITY OF BIRMINGHAM.

DEPARTMENT OF MINING.

Applications are Invited for

the POST of ASSISTANT PROFESSOR IN PETROLEUM TECHNOLOGY, at a commencing stipend of not less than £650 per annum. The successful candidate will be required to commence work on 1st October, 1920, to devote his whole time to the duties of the office, and to work under and carry out the instructions of the Professor of Mining. Applications, stating age, training and experience, accompanied by copies of three recent testimonials, should be forwarded to the undersigned on or before Saturday, July 10th, 1920.

Further particulars may be obtained from
GEO. H. MORLEY,
Secretary. H 117

COUNTY COUNCIL OF THE WEST RIDING OF YORKSHIRE.

EDUCATION DEPARTMENT.

APPOINTMENT OF FULL-TIME TEACHER.

Applications are Invited for

the POST of FULL-TIME TEACHER in the Engineering and Mining Department of the Normanton Technical School. Candidates must possess a degree or equivalent Diploma of a Technical Institution or a Technical Department of a University. Works experience and successful teaching experience is essential. They should be able to take Classes in all the subjects of Mechanical Engineering. Salary £300 to £450 plus a temporary bonus at the rate of £20 per term.

Forms of Application (which must be sent in not later than 5th July, 1920), and particulars of duties may be obtained from the SECRETARY, Technical School, Normanton, Yorks. H 87

THE WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

ALTHOUGH not one of the oldest of the group of firms who have made Lincolnshire pre-eminent in the agricultural engineering industry, the works of Messrs. William Foster and Co., Limited, at Lincoln, have nevertheless been in existence for something like sixty-four years. The Wellington Foundry was established in 1856, on the banks of the River Witham, in the lower part of the city, by the late Mr. William Foster, who had previously conducted a flour-milling business in the same premises. The founder of the works was a man prominent in the public life of the city and endowed with the foresight to appreciate the possibilities of an engineering industry of the type with which Lincoln is now so closely identified. He was elected Mayor in 1864, and died in 1876, not, however, before he had seen his own engineering business and others of a similar character firmly enough established to mark out Lincoln as the chief centre for many important classes of agricultural machinery.

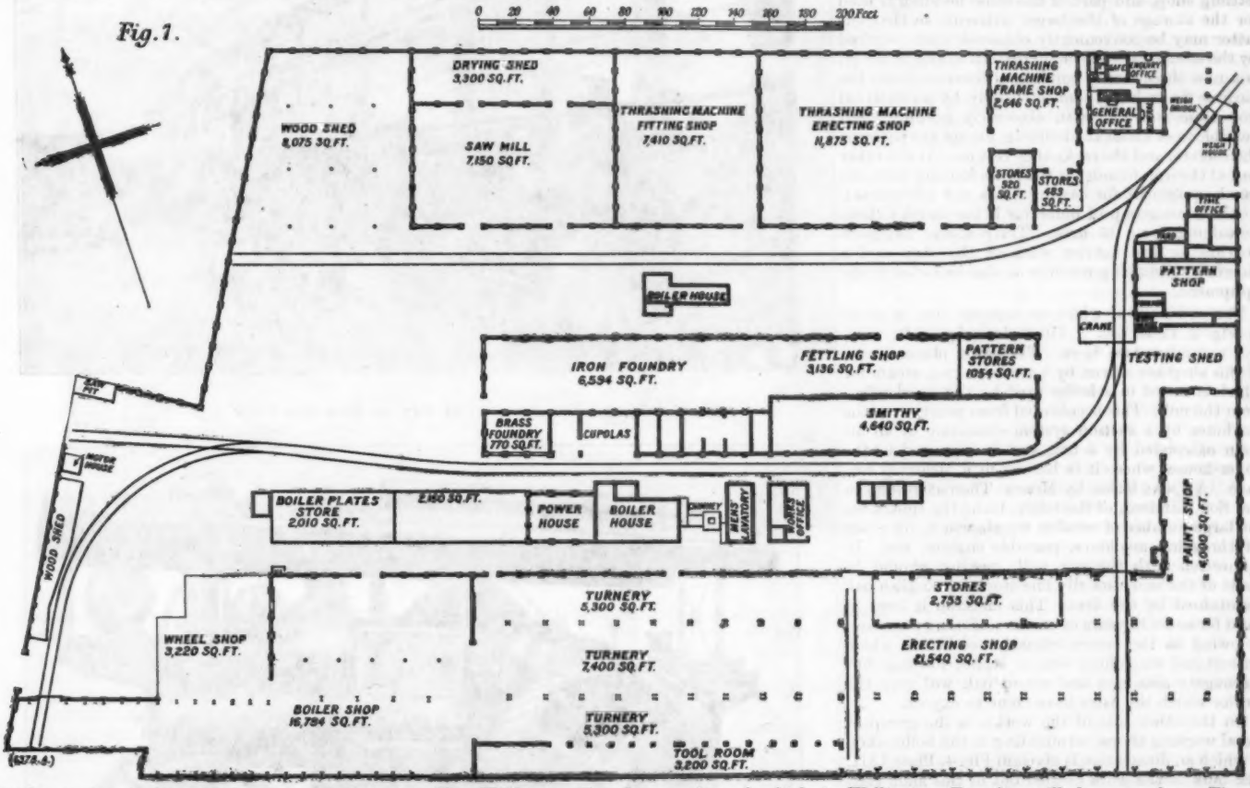
Soon after the death of Mr. William Foster, the undertaking was converted into a limited liability company, and by the year 1899, the firm found it necessary to erect a larger and more modern factory to accommodate their growing business. This new factory, still bearing the name of the Wellington Foundry, is the present home of Messrs. William Foster and Co., Limited. It will ever be memorable as the birthplace, both as regards design and construction, of the "tanks" which, more than any other single invention, turned the tide of battle definitely in favour of the Allies, and so contributed to the successful termination of the Great War. The activities of the firm in this connection will, however, be referred to later. It may, however, be mentioned at this point that the name "tank" as well as the article denoted by it, originated at Messrs. Foster's Works, and was not the outcome of any Whitehall deliberations, although the adoption of the name as a means of misleading our enemies as to the real nature of the machines under construction, until they should actually appear on the battlefield, must be placed to the credit of the Authorities. The true origin of the name is as follows: Sir William Tritton, the managing director of Messrs. William Foster and Co., Limited, who, in collaboration with Major W. G. Wilson, actually prepared the design, decided that the best way to secure secrecy during manufacture was to make no secrets about the matter. So two independent orders went through the shops, one for "experimental chassis" which might mean anything, but actually covered the propelling mechanism of the "tank," and the other for "water carrier for Mesopotamia," which really related to the body of the vehicle. The design of the "water carrier for Mesopotamia" was regarded rather scornfully by the men in the boiler shop, where it was built, as some freak idea of the managers', and since the title of the drawings was too cumbrous for the direct-minded British workman, it was not long before it was generally referred to as "that b——y tank." The admirable inappropriateness of the name as denoting the real functions of the machine was recognised, and henceforward the word "tank" acquired a technical significance which may possibly puzzle the etymologists of the future.

The manufacture of "tanks" is now, fortunately, a thing of the past, and Messrs. Foster have reverted for some time to the output of the machinery with which their name has always been associated. The normal products of the firm are traction, portable and semi-portable steam engines, steam wagons, steam and petrol tractors, trailers, and, in fact, all kinds of vehicles for heavy haulage. Not less important is the output of power-driven machinery of a definitely agricultural type, such as threshers, elevators, chaff-cutters, maize-shellers and the like. A speciality of the firm is the manufacture of "showman's" traction engines equipped with dynamos, and complete with all the special fittings and excellent finish demanded by the nature of their work. Like most of the Lincolnshire firms, Messrs. William Foster and Co., Limited, do a large foreign trade, especially with the great grain-producing areas of Eastern Europe, South America, India, Australia, etc.

The arrangement of the shops constituting the Wellington Foundry will be seen from Fig. 1, above, to which we have already referred, while the nature of the various buildings and an idea of their equipment will be gathered from the interior views, Figs. 2 to 9, on Plates LII to LV, and Figs. 10 and 12, pages 848 and 849. The plan of the works is so laid out that the shops fall into three main groups. The foundry, smith's shop, and power house constitute the main items of the central group, which is flanked on one side by the wood-working shops, and on the other by the machine shop, erecting shop and boiler shop.

The power-house contains two Bellis-Holmes direct-current generating units of 100 k.w. rated capacity each, which work in conjunction with a storage battery. Current is also taken from the mains of the Lincoln Corporation, and Corporation power is, in fact, used exclusively during the summer months. The engines in Messrs. Foster's power-house are non-condensing, and are only operated when their exhaust steam is required for heating the works. As this coincides fairly well with the period of the year when the Corporation plant is loaded up, the understanding by which the Wellington Works generate their own current during the winter and take power from the Corporation only when the latter has excess machinery available, permits of an arrangement which is very beneficial

Fig. 1.



to both parties. The works voltage is 220 volts, and as the Corporation current comes in on the three-wire system with 440 volts between the outers, the various circuits are divided between the two sides of the system and a small balancer-set deals with the out-of-balance current. Every circuit, however, can be connected to either side of the system at will by means of change-over switches on the board, so that the attendant keeps the system generally in balance and leaves the automatic balancer only small and temporary out-of-balance currents to take care of.

The iron foundry, a view of which is given in Fig. 2, Plate LII, has a floor area of about 157 ft. by 42 ft., and is served by a 10-ton overhead travelling crane. Two cupolas, having a combined capacity of about 10 tons of iron per hour, serve the foundry. A Roots blower for the cupolas and a motor-driven sand mixer complete the mechanical equipment, except for eight small moulding machines of a simple type. At the end of the iron foundry is the fettling shop, and part of the same building is used for the storage of the larger patterns, so that the latter may be conveniently obtained when required by the moulders. The main pattern stores, however, is a new three-storey building of ferro-concrete, the various floors being connected only by an external iron staircase, and with absolutely nothing combustible in or about the building, except the patterns themselves, and the racks they rest on. At the other end of the iron foundry is the brass foundry with the usual equipment for casting brass and whitemetal. In the same group of buildings is the smith's shop, containing some 15 fires. Three steam hammers provide for the heavier work of the shop and a Horsfall boltmaking machine is also included in the equipment.

The saw-mill, of which an interior view is given in Fig. 3, Plate LII, is 110 ft. long by 65 ft. wide, and comprises two bays. The saws, planers, etc., in this shop are driven by a steam engine, steam for which is raised in a boiler fired by the wood refuse from the mill. This is collected from points near the machines by a suction system consisting of an air main exhausted by a fan, and is deposited in the boiler-house, where it is burned in a Meldrum furnace. A spoke-lathe, by Messrs. Thomas Robinson and Son, Limited, of Rochdale, turns the spokes for the large number of wooden wheels which are made for thrashing machines, portable engines, etc. In connection with the saw mill, mention should be made of the exceptionally fine stocks of English oak maintained by the firm. This material is kept in hand for some 10 years or so, for seasoning purposes, as owing to the severe climatic conditions which agricultural machinery has to stand, nothing but thoroughly seasoned and sound oak will give the service which the users have come to expect.

On the other side of the works, is the group of metal working shops, terminating in the boiler-shop of which an illustration is given in Fig. 4, Plate LIII. The bulk of the work carried out in this shop consists of the manufacture of locomotive type boilers for traction and portable engines, steam wagons, etc., although Lancashire and other boilers up to 30 ft. long by 8 ft. diameter are also built when occasion demands. The equipment of the shop includes a plate-edge planer, four Asquith electric drills, a boiler shell-drilling machine by the same makers and hydraulic flanging machines and riveting machine by Fielding and Platt and Henry Berry and Co. It was in this shop that the body of the first "tank" was constructed and towards the latter end of the war, these machines were leaving the works at the rate of ten per week.

At the end of the boiler shop are the bays of the machine shop, interior views of which are given in Figs. 5, 6 and 7, Plates LIII and LIV. The legend painted on the travelling crane in Fig. 5, shows the pride felt by the whole staff of the firm in their creation of the battle monsters which terminated the impasse in Flanders and started the collapse of the German armies. The interiors of the erecting shops are illustrated in Figs. 8 and 9, Plate LV, and Fig. 10, annexed. Fig. 8 shows the steam wagon bay and Figs. 9 and 10 the bay devoted to road locomotive engines, the first view showing the appearance of this shop during the war when tanks constituted the chief output of the firm, and the second view representing the same shop engaged on its present-day products. The tanks seen in Fig. 8 are of the "Mother" type, the first of the real tanks to be devised. "Mother's" predecessor was "Little Willie," a caterpillar tractor which failed to justify expectations much as its Imperial namesake did when called upon for an effort, with the result that "Little Willie" proved the last of his type.

A Short History of the Tanks.

An authentic account of the conception and development of the tank has recently been published by Messrs. William Foster and Co., Limited, from which the following facts are taken. Shortly after the outbreak of the war, Messrs. Foster's were asked to supply tractors capable of transporting 15-in. Howitzers, and the firm undertook to design and construct 97 tractors and 291 special trailers which would serve the purpose. Designs were prepared in their own works without official supervision, for 105-h.p. tractors with driving wheels 8 ft. diameter. The first machine successfully passed its trials on December 3, 1914, and early in 1915 the whole of the contract was completed. A chance remark by Admiral Bacon, made on the day of the trials, led Mr. Tritton, as he then was, to look into the possibilities of a machine which could cross a trench, and he proceeded with the design of a wheeled tractor, somewhat similar to that used for hauling the howitzers, which should carry about its own portable bridge. A machine of this type was built, and proved capable of crossing an 8-ft. wide trench in 3 minutes, but the weight of the bridge and of the armour which would be necessary under conditions of warfare, were considered to make it impossible to use such a machine in the battlefields of Flanders. The solution of the problem appeared to lie in the employment of a chain-track tractor, a type of machine with the manufacture of which Messrs. Foster had had practical experience, and Mr. Tritton was working on such a design, when he learned that a Landships Committee had been appointed by Mr. Winston Churchill, under the chairmanship of Sir Eustace d'Eyncourt, to consider the question of evolving a fighting machine which would cross trenches. The committee paid a visit to Foster's works on April 13, 1915, to inspect the "Bridge" machine. They also came to the conclusion that some kind of chain-track tractor was necessary, but did not get much farther than this, and on July 30, 1915, they sent for Mr. Tritton and, admitting they had made no progress, asked him to take over the whole problem and solve it as best he could, utilising the experience of Major W. G. Wilson, in connection with it. The only engineering provision specified by the Admiralty was that Mr. Tritton should use a pair of American caterpillar tracks which they placed at his disposal.

Immediately on receipt of these instructions

Fig. 10. South Bay of Erecting Shop

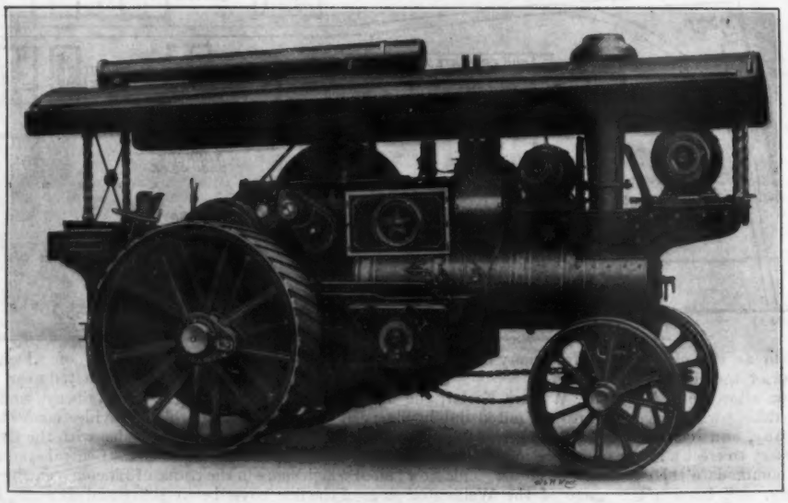


Fig. 11. Showman's Road Locomotive.

Messrs. Foster started on the construction of a machine, using a Daimler engine and other parts of a Foster heavy tractor, taken from their stores. By September 14, 1915, or no more than 37 days from the commencement of design, "Little Willie" was ready for trial. The machine was unsatisfactory because the tracks would not keep on. The form of track which subsequently became the standard for all tanks, was then devised by Mr. Tritton and fitted to "Little Willie." This made it reasonably satisfactory, but the position of the tracks at the sides of the body gave rise to very great difficulties with regard to the disposition of the guns. A masterly idea of Major Wilson's, namely, that the tracks should be carried right round the machine instead of upon two side girders, not only provided a projecting nose for climbing, but left the sides clear for gun sponsons. This gave the tank its now familiar form, and the designs of "Mother" the first of the type, were begun at Lincoln on August 24, 1915. On September 29, a wooden "mock-up" was approved by the authorities, and Mr. Tritton was urged to complete a machine. The work of construction could not be started before October 28, owing to lack of materials, but by January 6, 1916, the tank moved under its own power. The trials at Lincoln were so eminently successful, that the machine was conveyed by night with extraordinary precautions of secrecy to Hatfield Park, where, on February 2, in the presence of a most distinguished gathering, including Mr. Lloyd George, Lord Kitchener, General Sir William Robertson, and many other prominent men, "Mother" was put through an elaborate programme. Every obstacle was successfully surmounted, and the trials were completely successful.

An order for 25 similar machines, to be ready for action in France by September, was immediately placed with Messrs. Foster, the order being increased to 150 in a few days time. Messrs. Fosters supplied detailed drawings to all other firms which were called upon to help in the production of tanks, and soon these machines began to collect in appreciable numbers at the tank training ground at Elvedon, in Norfolk, where, in June, 1916, a mock battle was fought. On September 15 the tanks first went into action in France, and the result of their appearance is still fresh in everyone's memory.

The large scale upon which the manufacture of tanks and their components had to be carried out involved the necessity of employing the resources of many of the leading engineering firms upon their production, but the responsibility for all matters of design was left by the Government in the hands of Mr. Tritton and Major Wilson, whose signatures were necessary on every approved drawing. In February, 1917, the honour of knighthood was conferred upon Mr. Tritton in recognition of his achievements.

Following the "Mother" tank, which weighed 30 tons and had a maximum speed of 2½ m.p.h., the "Whippet" type was introduced, with the idea of providing the army with a lighter and more agile machine suitable for the more open warfare which the heavier tanks had brought about. The "Whippet" design was due to Messrs. Foster and Co., who had the first machine on the trial ground within three months of the commencement of the drawings from which it was built. The "Whippet" weighed only 11 tons, and though armoured as heavily as the "Mother" type, it carried only machine guns as armament. Its maximum speed, however, was more than 9 m.p.h. over broken ground, and its mobility and ease of steering were so great that it proved itself capable of running down and destroying the fleeing enemy. After the trials of the first of the Whippets an order was placed with Messrs. Foster and Co. for 400 tanks of this type, and the first of these went into action in March, 1918, and proved of immense value in stemming the German onslaught in the spring of that year.

FIG. 12. PART OF THRESHING MACHINE ERECTING SHOP

The next step in the evolution of the tank was the design of the "Hornet" type by Messrs. Foster. The "Hornets" had the speed of the "Whippets," with greater offensive power than the "Mothers." They needed a crew of five men only, as compared with the seven who were required to operate "Mother," and these five were working in conditions of ventilation and temperature incomparably better than those endured by the first tank crews. Moreover, the "Hornets" were capable of much cheaper and more rapid manufacture than had characterised the earlier designs. In fact, they were regarded as the last word in tanks, and immediately after the first trials of the type, in April, 1918, an order for 200 of them was placed with Messrs. Foster, and orders for 6,000 more with other firms to whom Messrs. Foster supplied drawings. At the time of the armistice only 36 "Hornets" had been constructed—all by Foster's—and the whole of the contracts were cancelled. It may be mentioned that by this time the total number of tanks of all kinds delivered to the British Army was 2,696, and 8,000 more were in course of construction or on order in Great Britain.

ROAD LOCOMOTIVES AND STEAM WAGONS.

Views of the shops used for the erection of steam road vehicles are given in Figs. 8 and 9, Plate LV, and Fig. 10, page 848. The latter view, as already stated, shows the same shop as illustrated in Fig. 9 under war conditions, when it was used as the tank-erecting shop. Traction engines are built by Messrs. William Foster and Co., Ltd., both simple and compound ranging from 14 brake horse-power to 50 brake horse-power. These powers are the economical ratings of the engines, but nearly 50 per cent. greater power can be developed if the engine is called upon to do so. The "Wellington" tractor, built to comply with all the regulations of the Light Locomotives Act, has for long been a speciality of the firm and large numbers have been supplied for road haulage. This tractor is fitted with a compound engine, having cylinders 4¼-in. diam. and 6¾-in. diam., by 9-in. stroke, which develops 14 brake horse-power at its economical rating when running at 250 r.p.m. Eighteen brake horse-power can be obtained continuously at a slight sacrifice in economy, and for short periods the engine can be used to develop 22 brake horse-power by admitting live steam to the low-pressure cylinder. Under the Act, a road tractor is limited to a maximum haulage load of 8 tons, and to a maximum speed of 5 miles per hour, though this speed can be exceeded by the machine in question, which can haul eight tons up gradients of 1 in 20 on top speed, or up gradients of 1 in 8 on second speed.

The overall dimensions of the tractor are 14 ft. long by 5 ft. 10 in. wide and the weight, empty, is 4¾ tons. The driving wheels are 62 in. diameter by 12 in. wide on the tread. The normal working pressure of the steam is 210 lbs. per sq. in., and the side tanks and tender contain 153 gallons of water, which will suffice for a journey of about 18 miles. A special feature of the tractor is the effective manner in which the springing of the back axle is carried out. The weight of the back end of the engine is carried on two laminated springs 40 in. long, placed above the main axle and outside the hornplates. There are none of the usual compensating levers, and the visibility of the springs ensures them the very slight amount of attention they need. The front axle is sprung in the usual way. A winding drum, carrying 150 ft. of 1¼-in. wire rope, is mounted on the back axle, so that the engine can extricate itself or its load from awkward places.

The showman's engine, illustrated in Fig. 11, page 848, represents a class of road locomotive which has been highly developed by Messrs. Foster and Co. The engine, which is of the compound type, having cylinders 7¼ in. and 11¼ in. by 12-in. stroke, develops 51 brake horse-power as a continuous economical load, but is capable of a maximum of 65 brake horse-power on emergency. The locomotive has three speeds, nominally of 2, 4 and 6 miles per hour respectively, and will haul a load of 26 tons up a gradient of 1 in 20 on good roads, or the same load up a gradient of 1 in 8 on the low speed. It has driving wheels 6 ft. 6 in. diam. by 21¼ in. width of face. For the purposes of the travelling showman, it is fitted with electric generating plant, consisting of two continuous current dynamos mounted on a bracket over the smoke-box. The smaller of these acts as the exciter for the larger one, and also furnishes current for illumination. The reason for the separate excitation of the main dynamo is to provide full voltage when the latter starts, so that the heavy work of starting up the loaded merry-go-round shall be performed without reducing the speed, and, therefore, the pitch of the organ which makes music for the riders. The showman's engine has all the features of a well-appointed traction engine in addition to its special equipment. It carries the usual winding drum on the back axle, cast-steel change-speed gear with safety interlocking device, differential gear, etc. The workmanship, quite apart from the special ornamentation, is exceedingly good, and, in fact, the finish of all Messrs. Foster's engines is gratifying to observe after the period of "war finish," which we have passed through.

THE FOSTER MAIZE SHELLER.

The threshing machine erecting shop is illustrated in Fig. 12, annexed. Threshing machines and elevators are, however, by no means the only products of this shop, chaff-cutters, haulage wagons, etc., forming a considerable proportion of the output. Another important branch of manufacture is that of maize-shellers, which have constituted one of Messrs. Foster's specialities for more than 35 years. One of the most recent designs is a duplex machine

DOUBLE DRUM MAIZE SHELLER.

CONSTRUCTED BY MESSRS. WILLIAM FOSTER AND CO., LIMITED, ENGINEERS, LINCOLN.

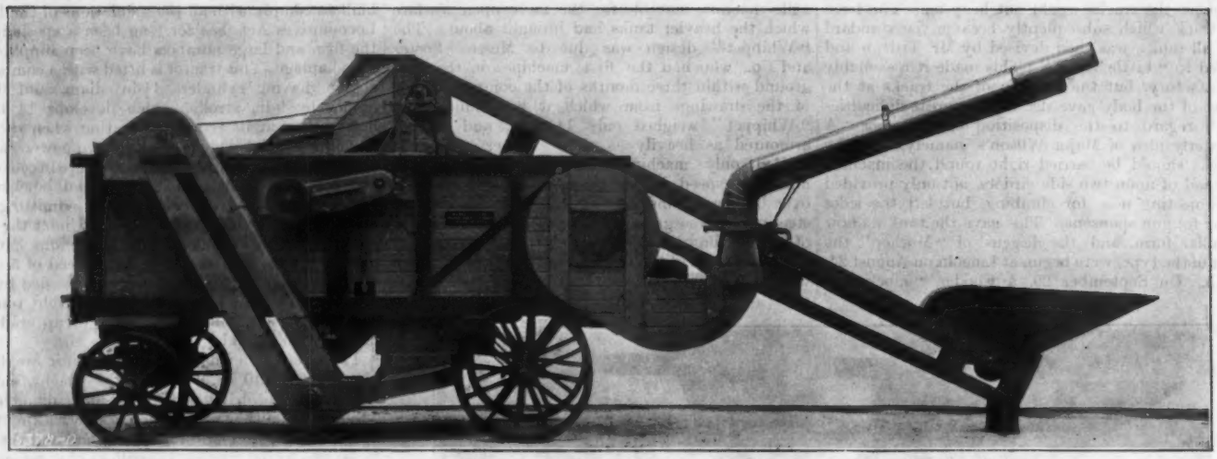
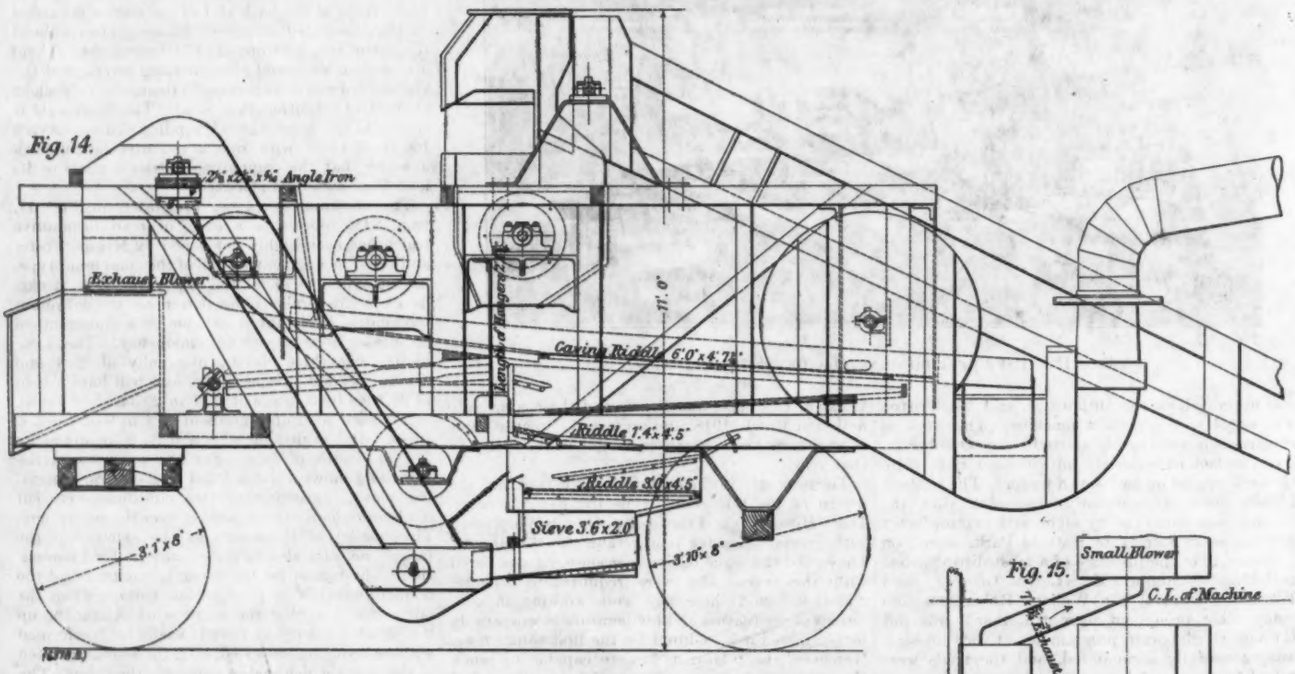
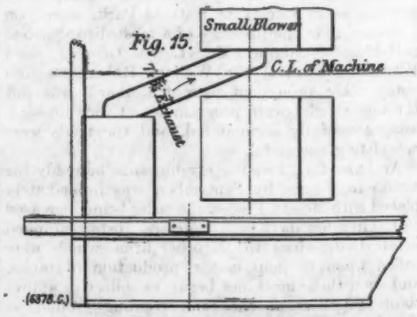


FIG. 13.





illustrated in Figs. 13 to 15, annexed. The corn cobs are thrown into the boot of an elevator, the lower end of which rests upon the ground as shown. This elevator is jointed and can be folded up for travelling. At the head of the elevator the cobs are divided, half going to each shelling drum. The shelling drums or helices, are partially surrounded by "concaves" made of equally-spaced bars of hard steel. The back drum is driven directly from the engine, and power is transmitted from it to the front drum by means of an enclosed silent chain, running in an oil bath. Either drum can be readily removed without disturbing the concaves. From the shelling drums the corn passes down on to the dressing shoes which oscillate in opposite directions. The top shoe contains a steel riddle for removing the shelled cobs which pass down a shoot at the end of the shoe into a blower which delivers the spent cobs at some distance from the machine. The bottom shoe is fitted with steel plate dressing sieves, easily accessible for cleaning or changing. Both shoes are suspended on ash-spring hangers all of equal length, and are driven from the crank by connectors, also all of equal length.

From the dressing shoe the maize is delivered into a corn elevator, the case of which is fixed outside the sheller frame, and the elevator raises the corn to the sacking hopper. A small blowing fan takes its suction from this hopper and so removes any dust carried over with the corn, ensuring a clean sample. This fan delivers its air under the cages, keeping them and the top riddle clear of refuse.

A machine of the type illustratod has shelled, cleaned and bagged up to 16 bags of maize per minute, each bag weighing about 140 lbs. This performance was not made under test conditions, but was carried out in actual work on a South American farm.

BRITISH PRODUCTION OF IRON AND STEEL.—The British production of pig-iron, and steel ingots and castings last May, was the highest yet recorded since the armistice, the production of pig-iron amounting to 738,000 tons, and that of steel ingots and castings to 848,000 tons.

UNITED STATES EXPORTS TO BURMA.—Iron and steel products, says *The Iron Age*, New York, not including hardware and machinery, constitute one of the leading imports into Burma, according to a report from the United States Consul at Rangoon. The value of their imports amounts normally to nearly 5,000,000 dols. per year. Including machinery and hardware, the total normal value of articles imported would be nearly double this amount and would hold second place to cotton goods among the imports of Burma. With the development of Burma's resources, of which there is great promise, the demand for these products is bound to increase.

FOURIER, BESSEL AND CLIFFORD.

By C. E. WOLFF, M.Sc.

IN ENGINEERING of March 14, 1919, there appeared a note by Sir G. Greenhill on "The Bessel-Clifford Function." In this article he called attention to a forgotten posthumous note by Clifford, in which the latter makes a start with a discussion of the properties of an alternative function to the ordinary Bessel function. This function is defined by

$$C(x) = \Sigma (-x)^k / (\Pi k)^2.$$

The subject was further developed by him in the *Philosophical Magazine* for November, 1919, and it was there shown by examples how much simpler physical and engineering calculations involving the use of Bessel functions became when Clifford's form is used in place of the ordinary form of the function.

It would seem, however, that Greenhill is wrong in attributing this function to Clifford, as it had already been used by Fourier as far back as 1822 in his "Théorie Analytique de la Chaleur." It is thus older than the ordinary Bessel function, which was first introduced in a memoir published in 1824 in the Transactions of the Berlin Academy. It is quite possible that Clifford, after starting on the subject, had his attention called to Todhunter's "Functions of Laplace, Lamé and Bessel," published in 1875, where a short chapter is devoted to the subject under the heading of "Fourier's Expression." This would account for the fact of Clifford's paper not being published during his lifetime.

In Fourier's Chapter VI the equation to be solved is :—

$$\frac{d^2u}{dx^2} + \frac{1}{x}\frac{du}{dx} + g\,u = 0.$$

which would now be called a Bessel equation, having a solution $u = J_0(\sqrt{g}\,x)$. To solve the equation, however, Fourier substitutes θ for $g\frac{x^2}{2^2}$, thus reducing it to the form :—

$$\theta\frac{d^2u}{d\theta^2} + \frac{du}{d\theta} + u = 0$$

with the solution $u = C_0(\theta)$ (in Greenhill's notation). A second solution, corresponding to the Neumann function is also given by Fourier, together with a short section devoted to the principal properties of the functions.

The history would, therefore, appear to be this. Fourier in 1822 showed how to obtain a solution for an equation in Bessel's form, and also showed how to expand a function in terms of a series of sines of multiple angles, and how to obtain the coefficients of the successive terms. Bessel, two years later, applied these methods to the solution of the problem in elliptic motion which is known by his name. Thus, having given

$$y = z + x \sin y$$

he showed that

$$y - z = 2\left\{J_1(x)\sin z + \tfrac{1}{2}J_2(2x)\sin 2z + \tfrac{1}{3}J_3(3x)\sin 3z + \frac{1}{n}J_n(nx)\sin nz + \ldots \text{ etc.}\right\}$$

In this result it will be noted that the usual extraneous factors involving powers of x (which are the source of so much trouble in problems involving integration or differentiation with Bessel functions) have cancelled out and disappeared. Hence for this particular problem the ordinary Bessel form possesses advantages, and was no doubt adopted for this reason. Otherwise, in practically every case, Fourier's original function is much the simpler.

With reference to the objection that the tables of the Bessel functions already calculated and published would be rendered useless, and that new tables would have to be calculated, it may be suggested that the same objection must have been felt to the introduction of Briggs' logarithms. But, in any case, it will be found much simpler to make use of the Fourier function in the body of the work, even if it is necessary to transform the final result to Bessel functions in order to obtain numerical values. The final transformation involves very little work, and the previous simplification is very great. In time, if the demand should prove sufficient, new tables may be relied upon to put in an appearance, and Bessel can then be left to the astronomers.

200-TON STEAM FLOATING CRANE.

IN our description of Messrs. Cammell Laird and Co.'s shipyard, in our issue of last week, we referred to the 200-ton steam floating crane which forms part of the equipment of the fitting-out basin. We are now able to illustrate this interesting machine and, on Plate LVI, will be found a series of figures which will explain its general features. The crane was constructed by Messrs. Cowans, Sheldon and Co., Limited, of Carlisle, and the barge was built by Messrs. Cammell Laird themselves. The maximum lift is 200 tons, at 65 ft. clear of the barge, on two blocks which lie side by side and which can be coupled by a cross-head when a heavy lift is to be made. Each block can independently lift 100 tons. There is an additional 30-ton block on an extension of the jib which lifts 97 ft. 6 in. clear of the barge. The main lifting gear can deal with 200 tons on two blocks at 8 ft. a minute and 100 tons on two blocks at 16 ft. a minute. On either block 100 tons can be lifted at 8 ft. a minute or 50 tons at 16 ft., a minute. The auxiliary 30-ton block has a lifting speed of 40 ft. a minute. The general lay-out of the crane and the positions of the main and auxiliary lifting gears will be seen from Figs. 1 to 3, on the Plate.

When the crane is lifting 200 tons at the maximum radius and the barge has 300 tons of water ballast—on board there is a forward list of 3 deg., as illustrated in Fig. 4. With no load and the jib in its highest position, there is a list of 3 deg. in the opposite direction, as shown in Fig. 5. The full range of derricking takes 20 minutes when a load of 200 tons is being carried; and 10 minutes with a load of 30 tons, the derricking mechanism containing a 2 to 1 gear which can be thrown in or out. In addition to the main lifting gears which we have referred to there is a travelling monkey fitted underneath the jib for use when the jib is fully out. It can lift 5 tons at 130 ft. a minute, and has a travelling speed of 100 ft. a minute. This monkey, with its block, can be seen in Fig. 2. All lifting gears on the crane have satisfactorily passed a 20 per cent. overload test. The barge is equipped with steam-driven bilge and ballast pumps and also a small steam-driven electric generating set for lighting the barge and for supplying large illuminating lanterns which are attached to the jib in order to facilitate lifting operations during dark weather or at night. Originally steam was supplied from a three-furnace coal-fired marine boiler, but this is now being replaced by a Babcock and Wilcox marine type water-tube boiler of 2,000 sq. ft. heating surface, and arranged for oil firing. This work is being carried out to facilitate bunkering and to avoid the necessity of the crane having to leave its work to get to bunkers.

FRENCH YEAR BOOK OF MINES AND WORKS.—We have received a copy of the *Annuaire des Industries Minières et Métallurgiques*, 1920, which is published by the Société de l'Industrie Minérale, whose Paris offices are 35, Avenue des Champs-Elysées. It gives the statistics of the Institution, lists of members and of the French mining inspectors, particulars as to the French mines and iron and steel works, the information including the names of the members of the Board of each concern, the output and other data.

BRONZING OF ALUMINIUM.—In 1915, O. Bauer and O. Vogel, of the Materialprüfungsamt, proposed to protect aluminium and aluminium-zinc alloys against corrosion by water from the supply mains and by sea water, by submitting the metal to an electrolytic treatment in aqueous solutions of alkali carbonates and chromates. In *Metall und Erz*, of January 21 last, L. von Grotthuss suggests the use of sulpho compounds of molybdenum for the same purpose. The cleaned sheet metal is made cathode in the bath, which is kept at about 60 deg. or 65 deg. C., the anode being a plate of zinc. The aluminium becomes coated with a brown-black deposit which is said to adhere well and to bear mechanical working. Corrosion tests were made in salt water, which was renewed every week; the bronzed aluminium or aluminium alloy remained uniformly bright whilst the untreated metal was badly attacked. The same result was obtained in ordinary tap water. Even under the microscope the bronzed aluminium proved to have remained intact. The paper does not give any information about the nature of the molybdenum compound nor the concentration of the solution.

PELTON WHEEL RECONSTRUCTION.

By PERCY PITMAN, M.I.M.E.

THE reconstruction herein described was carried out by the writer at a large munition works during the war period, and may be of some little interest to engineers. The objects of the reconstruction were twofold. Firstly, to replace defective and broken buckets which were becoming a source of considerable danger, and secondly, to economise water by fitting on buckets of a more modern and efficient type.

The work was of a difficult and arduous nature, as the dismantling of the old buckets and fitting on the new ones had to be carried out on the turbine as it stood in the Power House, and as only the top cover could be removed it will be understood that the position was a very cramped one in which to work.

The turbines were of the Pelton type, made by Ganz and Co., of Buda Pesth, and were installed in 1907, and the data relating to the plant are as follows: Head of water, 1,010 ft.; pipe line, 3 ft.; internal diameter and 3,600 ft. in length. Each Pelton wheel consisted of two 4 ft. diameter steel disc runners mounted on one 9½ in. diameter steel shaft, each wheel being fitted with 22 buckets. These buckets were staggered, *i.e.*, the buckets of one runner being equidistant between two buckets on the opposite wheel. Each of these wheels was served with a deflecting nozzle having a trunnion at one end and a gland at the other, but both of the nozzles were connected up by means of a rock shaft and links, so that they were operated simultaneously by means of a servomotor actuated by the usual compensating type hydraulic governor. Fig. 1, on page 852, shows a side elevation with the new buckets fitted on. Each unit drove two Bruce-Peebles generators of 500 kw. coupled in tandem and having a normal speed of 450 r.p.m. The plant was run on 24-hours' service, the men working in three shifts, while the units frequently ran for many months at a stretch without stopping.

The old buckets, Figs. 2, 3 and 4, and the old needle and nozzle, Fig. 5, were of an extremely bad shape. The buckets were continually breaking, resulting in serious static unbalance, and the needle and nozzle produced a bad "flaring" jet of water, as shown by Fig. 6, while the first two-thirds of the closing movement of the needle made practically no reduction in the quantity of water vented. It was difficult to remove the old bolts, and many of these had to have the centres drilled out by means of an air drill before they could be removed by hydraulic pressure. These old buckets were much too wide, and evidently had been originally intended or designed for a much larger plant. The buckets were also set on the runners with too much rake or backward slope, which resulted in the jet of water slapping the inside face of the bucket, producing hydraulic losses, and the resulting water hammer was no doubt the cause of the buckets becoming broken. There is also a waste of water with a bucket of this type, as after it has passed the theoretically best position (namely, at right angles to the entering jet), it is doing little work. An efficient bucket should reverse the stream as nearly as practicable through 180 deg., but an examination of one of the units in operation disclosed the fact that a great quantity of water was being flung violently downwards into the wheel pit. To carry out this examination the writer, furnished with oilskins and sea boots, &c., and with a powerful acetylene light entered the underground tunnel, or tail race, by way of the turbine under construction. It should be understood that this end of the tail race was a cul-de-sac and was filled with dead water. At the bottom and on each side of the housing was a low wall running right across the tail race, this being placed there with a view of always keeping a body of water into which the discharges from the nozzles could shoot when they were deflected off the wheels, thus wasting their energy without damaging the foundation. The jets, when deflecting shot into the tail race in an opposite direction, and away from where the writer was approaching. The first of these turbines was at the time running under full load conditions. Down the sides of the housing a

thin curtain of water was falling, and through a gap in this (caused by the shelter of the nozzle and pipe up above) the writer put his head and noted that much water appeared to be deflected from the buckets in an almost vertical direction down into the wheel pit, this no doubt being caused by the before-mentioned backward rake with which the buckets were set on the wheels. Large quantities of water appeared to be thrown up into the top of the housing, and by again falling on the wheels a second time must have caused additional loss to that from windage. With modern turbines the runners pass through a baffle plate or water guard with a very small clearance, as shown at X and X_1, in Fig. 7, which is a good example of the method now generally adopted on the Continent and in America.

When the jets were deflected right off the wheels, due to a big reduction in load, they continued to swing up and down, owing to the governor hunting badly, and when finally the jets came to rest they appeared to be on a different and slightly larger pitch circle.

The old nozzles gave a jet with a mean contraction of 70 mm. In the latest practice among turbine engineers, the diameter of the stream should be about three-tenths the width of the bucket, so that the absurdity of using a bucket 16½ in. wide for a 2¾-in. jet of water becomes apparent.

Turbine manufacturers are naturally reluctant to give workshop and drawing office methods of bucket formation and lay-out, and one finds little of practical value in text-books. The author, therefore, presents the complete lay-out for the new buckets here shown by Figs. 8, 9 and 10, and trusts it may prove useful to engineers who take an interest in this subject. The bucket is of the usual Pelton shape with the exception that it is slightly curved on the dividing wedge or splinter, and also on the bottom face of the bucket in a radial direction, with a view to give a larger radius of effective action, after the bucket has passed the theoretically best position (namely, when the bucket face is at right angles to the entering stream).

The drawings are self-explanatory and show the points from which the various radii are struck and the methods of setting out here shown are applicable to almost the whole range of impulse water-wheel design and manufacture, providing the load conditions, head of water, size of nozzle, and speed required are taken into consideration.

The new buckets were made of cast steel, machined a tight-press fit on the runners, and two steel bolts of 35 tons to 40 tons tensile steel, turned and ground to 1¼ in. diameter, were pressed, a body found fit, into reamed holes through the bucket lugs and runner. The total weight of the buckets was approximately 1 ton, and each bucket was brought to the same weight before being fitted to ensure perfect static and dynamic balance. By adopting the old dodge of placing one end of a steel rule against the bearings, and the other end against the teeth, the entire absence of vibration on the reconstructed turbines could be noted. The author designed a separate governor for the automatic regulation of the needles to enable the plant to take care of load changes, and at the same time economise water. Without going into a lot of formula the following readings will show the quantity of water which could be saved by automatic regulation of the needles, now in almost universal use on nearly every modern plant.

Reading for Turbine No. 1. (*Nozzle Full Open.*)

Time.	Amperes.	Volts.	Kilowatts.
p.m.			
9.0	7,700	134	1,032
10.0	7,700	134	1,032

Maximum reading during the day for this opening, 1,090 kw., which shows a loss the equivalent of 58 kw., or 5·32 per cent. or 3,950 cub. ft. of water wasted per hour.

Reading for Turbine No. 5. (*Nozzle Full Open.*)

Time.	Amperes.	Volts.	Kilowatts.
p.m.			
7.0	7,850	130	1,020
7.30	7,600	133	1,020

Maximum reading during the day for this opening, 1,115 kw., showing a loss equivalent to 95 kw., or 8·42 per cent., equivalent to 6,200 cub. ft. of water per hour wasted.

Referring to Fig. 11. The bad stream lines made by the existing steel nozzles R, are shown by dotted lines N. The new bronze nozzles R_1, gives a much straighter path N_1 through the nozzles. T and T_1 are the trunnions and G and G_1 the glands, while S is the T-shaped supply pipe. The springs M and M_1 shown on Fig. 11 were designed to improve matters, but unfortunately up to the present the plant could not be spared the necessary length of time to carry out such a desirable improvement. The old Ganz buckets, needle and nozzle, with 420 lb. pressure on the gauge gave 970 kw. corrected, and the new buckets with the existing steel nozzle and spear (which it should be noted was not made by the writer) gave 1,082 kw., and after allowing a substantial correction factor of 4 per cent., it showed an increase of 70 kw., or a net increase in efficiency of 7·3 per cent. The author acknowledges his indebtedness to Professor E. F. Eckhart of the University of Standford, San Francisco, California, for the loan of pitot tube which had been used by him for testing the hydraulic "input" of large Pelton wheels in America. Owing to the before-mentioned flaring of the jets the tests which were made were relative and not absolute, and they were only carried out with a view to assist in the design of the most efficient bucket. The writer cannot do better than refer readers who are interested

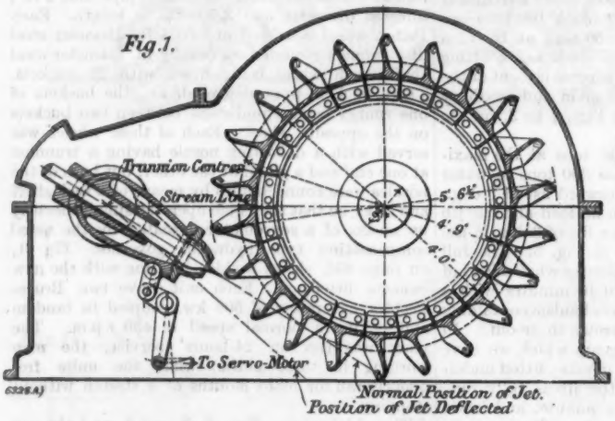


Fig. 1.

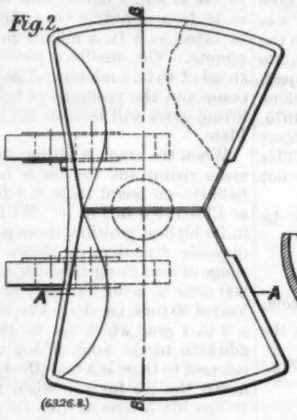


Fig. 2.

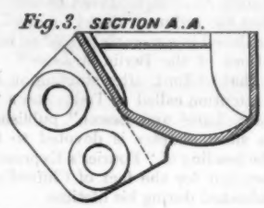


Fig. 3. SECTION A.A.

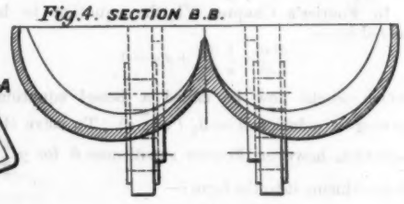


Fig. 4. SECTION B.B.

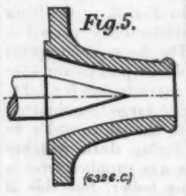


Fig. 5.

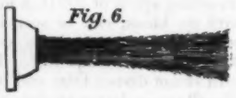


Fig. 6.

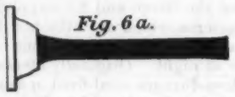


Fig. 6 a.

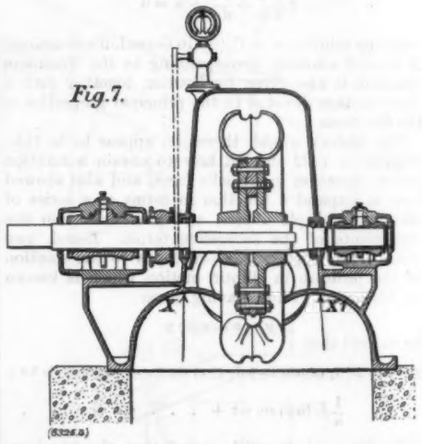
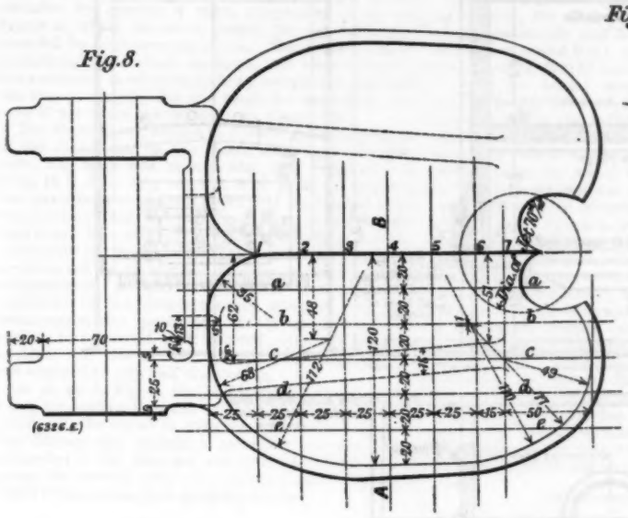


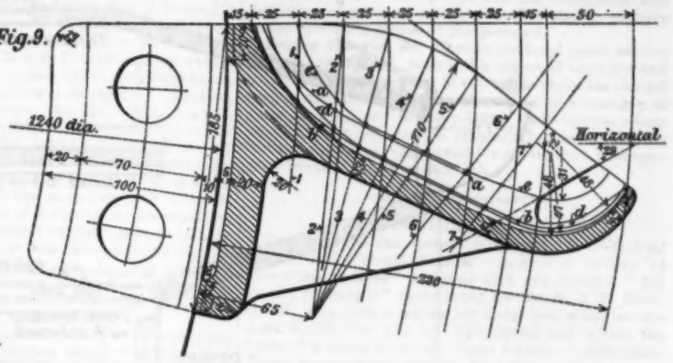
Fig. 7.

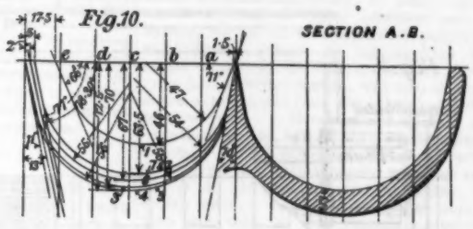
The "flaring" or spreading of the jets, of course, always takes place to some extent, but in this case it was very pronounced, and the author believes this could have been cured by machining away the "hump" which will be seen in the pipe and nozzle on Fig. 1. This trouble with the jet was due more to bad design of the steel nozzles than to the lay-out of the pipes. The drop in pressure, between the pressure gauge on the pipe and the gauge on the Pitot tube was in reality a drop through the nozzle, and it shows a low nozzle efficiency caused by the before-mentioned "hump." The stream lines of the water issuing from the nozzle did not conform to the shape of the needle but tended to leave it. The erosion of the needle tips proves this beyond doubt. The author suggested taking the needles out and turning them in the lathe so as to overcome this difficulty. The needle would, of course, have been pushed in a fraction farther, corresponding exactly to what had been skimmed off it. This would not alter the consumption of water in any way nor interfere with hand or automatic regulation. At this time cameras were taboo, otherwise a flashlight photograph would have confirmed the view of the "flaring" jet, Fig. 6, as not being in any way exaggerated. Unfortunately this examination was brought to a sudden end, as during one of the periods of hunting the load appears to have been suddenly thrown on again, and this caused the jets of water to strike the buckets on a new pitch circle, causing the deflected water to be shot violently and unexpectedly in the writer's direction. In groping his way back in the darkness he appeared to be stumbling over quantities of broken buckets, and one piece which was brought up to the surface, and shown by dotted lines on Fig. 2, will give a rough idea of the grave risks which were being taken by the men in running the plant in this condition.

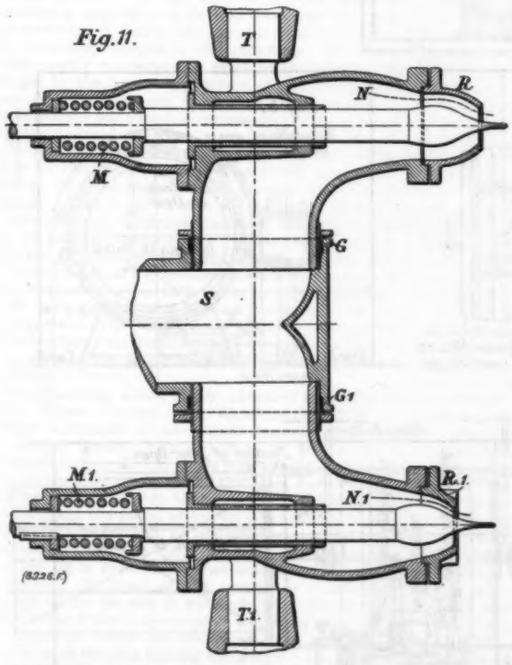
Owing to the high peripheral velocity, one hesitates to think what would happen in the event of one of these old buckets coming adrift, or fouling the nozzle. For the sake of comparison between the old bucket and the new, the writer has drawn the cross-section of the jet on the old bucket, Fig. 2.

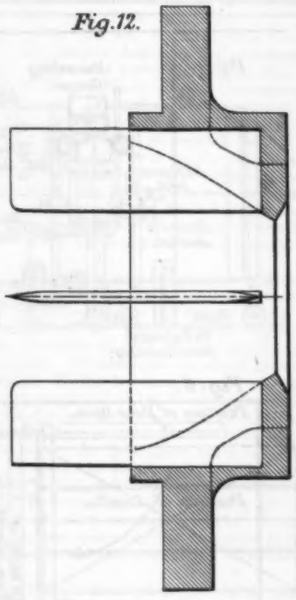
in the use of this apparatus to Professor Eckhart's most excellent paper, "The Application of the Pitot Tube to the Testing of Impulse Water Wheels," which was presented to the Institute of Mechanical Engineers, January 7, 1910, and which is quite a classic on the subject. The swinging or rotative parency, the water for about 2 ft. issuing almost like a glass rod (see Fig. 6A). Owing to the heavy cost of making these experimental nozzles and the research work carried out, no profit was made on the above reconstruction, but the writer hopes that the details may benefit other engineers.











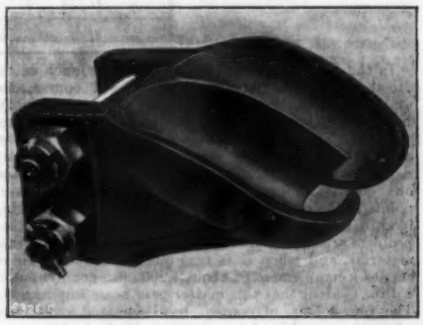


FIG. 13.

character of the stream produced great vibration, making it impossible to steady the Pitot tube satisfactorily. The jets of water had to be permanently deflected into the tail race during the test, and the author was roped up to a cross-member between the runners for safety, and owing to the great noise of the discharge verbal instructions were found impossible, and the amount of opening of the needle which was required was carried out by pre-arranged signals. The author was not satisfied with the jet, and with a view to obtaining one of greater solidity experimental nozzles were made in fluid-pressed bronze, into which were dovetailed four rustless steel blades, 5 mm. thick, which were ground and highly polished up to a thin knife-edge on the inside (see Fig. 12). These nozzles were a big improvement, producing a jet of extraordinary solidity and trans- The electrician in charge of the power staton. agreed that there was a further increase of efficiency of 5 per cent. due to this improvement. Unfortunately by this time the writer had reposted the Pitot tube to Professor Eckhart, otherwise some useful data could have been obtained. The great vibration produced at the back of the nozzle by the rotative or twisting character of the stream, seems to have produced fatigue of some sort in the steel blades, or possibly crystallisation, causing the blades to break off short at different intervals after they had been in use some months. Perhaps the vibration or water hammer at the back of the nozzle may have caused waves in harmony with the vibration period of the pipe, thus accumulating this destructive effect. It is just possible that this experiment is capable of further development. In conclusion it should be noted, that the steel nozzles shown at R, Fig. 11, and also in Fig. 1, have a larger mean contraction than either the Ganz nozzles, Fig. 5, or the experimental nozzles, Fig. 12, made by the author, and therefore pass a larger quantity of water, and any slight extra horse-power obtained on some of the other units was entirely due to this. It would be possible to obtain an overload up to 17 per cent., if desired, by increasing the mean contraction of the jets.

BRIDGE REPAIRS DURING THE WAR.—Bridge builders will find information concerning German bridge repairs and the construction of emergency bridges during the war in a series of illustrated articles on the "Work of German Railway-Construction Firms during the years 1914 to 1918," which Dr. Ing. H. Bösenberg has been publishing in recent issues of *Stahl und Eisen*. The articles deal with the operations on both the eastern and the western fronts, in which various firms participated.

GERMAN AGRICULTURAL MACHINERY.—According to a well-known German authority, says *The Board of Trade Journal*, the manufacture of agricultural machinery in Germany has been developed since the conclusion of hostilities owing to the demand both at home and abroad. The requirements of the home markets have been large owing to the long duration of the war and the lack of *personnel*, which has necessitated the replacing of human and animal labour by machinery. Before the war Germany imported from abroad: 90 per cent. of its requirements in mowing machines came from the United States and Sweden; 20 per cent. to 30 per cent. of its requirements in motor ploughs from United States of America; 20 per cent. of its requirements in hay machines from the United States of America; 60 per cent. to 70 per cent. of its dairy machines from Sweden and Denmark. It is now claimed that production has been increased, not only to supply its home market, but also to produce a surplus for export. It is hoped by the makers that this surplus will find a favourable market in Central and South America and in Asiatic markets.

INCINERATOR AND DISINFECTOR FOR NAVAL SERVICE.

CONSTRUCTED BY MESSRS. MANLOVE, ALLIOTT AND CO., LIMITED, ENGINEERS, NOTTINGHAM.

Fig. 1.

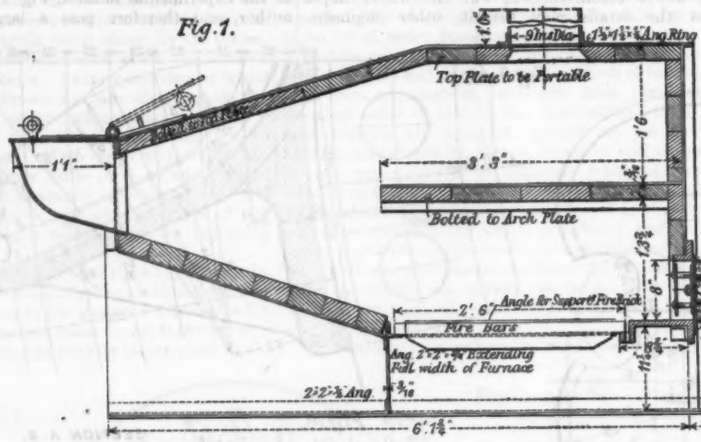


Fig. 2.

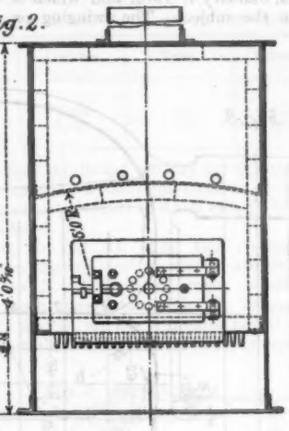


Fig. 3

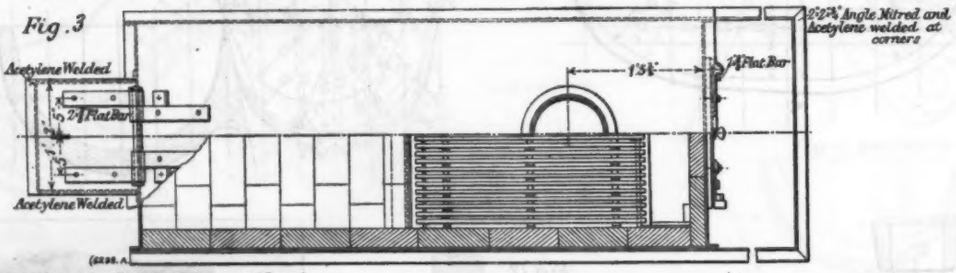


Fig. 4.

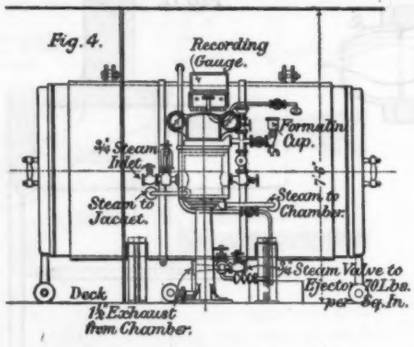


Fig. 5.

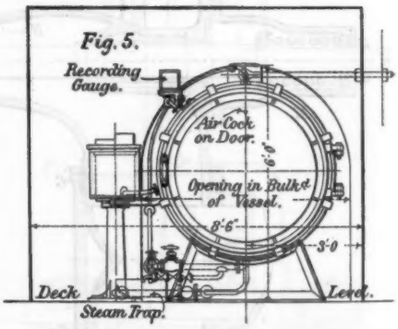
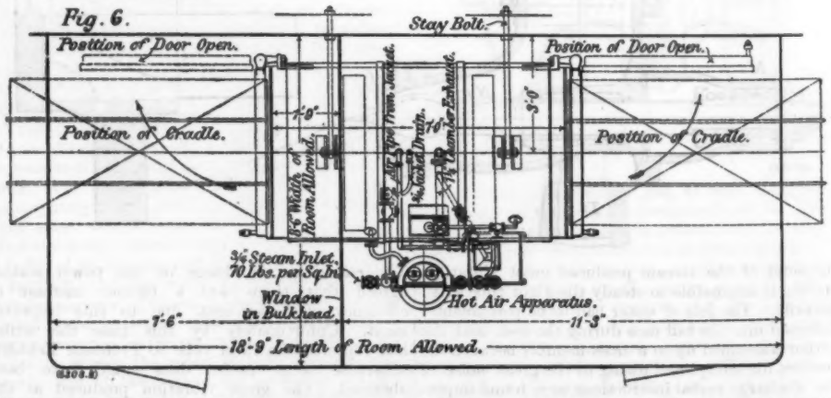


Fig. 6.



In the design of a modern battle-cruiser, such as the Hood, the main considerations are, of course, the efficiency of the vessel and her propelling machinery, but, in addition to these, there are a number of minor problems to be solved in order to ensure the comfort and well-being of the *personnel*. We have already dealt with the former on pages 397 and 423 *ante*, and one of the minor, but by no means unimportant, points in the design, viz., the arrangements for cooking food, has been referred to on page 422 *ante*. Another problem arises in connection with the disposal of refuse material, and when it is remembered that the Hood carries a complement of about 1,200 officers and men, it will be evident that this matter is of some importance. The refuse can, of course, be discharged overboard when the vessel is at sea, but it is likely to become a serious nuisance if disposed of in this manner when the ship is in port or at anchor near the shore. For this reason many of our larger naval vessels, including the Hood, have been fitted with incinerators in which all kinds of combustible refuse are burnt, this being by far the most sanitary method of disposing of this class of material.

Figs. 1, 2 and 3 annexed illustrate the incinerator made to Admiralty designs by Messrs. Manlove, Alliott and Co., Limited, of 41 and 42, Parliament-street, Westminster, London, S.W.1, and fitted on board the Hood. From the engravings, which are practically self-explanatory, it will be seen that the incinerator consists of a sheet-steel casing, lined with firebrick, and containing a grate 2 ft. 6 in. long and 2 ft. wide. Above the fire is a firebrick arch, as shown in Figs. 1 and 2, and behind it is a sloping hearth on to which the refuse material is delivered through a hopper provided with a lid. On this hearth the material is first dried by the hot gases from the fire in which it is afterwards consumed, the gases being directed over the hearth by the firebrick arch and leaving by a funnel near the front of the incinerator. The quantity of rubbish that can be disposed of in this way, of course, depends upon its nature and upon the quantity of moisture present, but under average conditions about ¾ cwt. can be burnt per hour, which is ample for the requirements of the ship.

Another item of utmost importance in preventing the spread of contagious diseases—which, in the comparatively confined quarters of a ship might easily develop into a serious epidemic—is the disinfector in which the clothing and bedding of men suffering from infectious diseases are treated in order to render them innocuous. The disinfector illustrated in Figs. 4 to 6 annexed was supplied by Messrs. Manlove, Alliott and Co., Limited, for use on the Hood, but a large number of similar appliances have been supplied by the firm for naval vessels of all types. The apparatus, which is made under Alliott and Paton's patents, consists of a steam-jacketed cylindrical vessel, 4 ft. in diameter and 7 ft. in length, constructed of boiler plate and provided with hinged doors at each end; the doors are fastened by swinging screw shackles. The infected garments, etc., are placed in a wire cradle which is mounted on rails, run into the cylindrical chamber, and there subjected to the action of dry-saturated steam at a gauge pressure of 20 lb. per square inch. The temperature of the steam, about 260 deg. F., is sufficient to destroy all germs, spores and vermin, but is not high enough to damage the fabric in any way. Steam is supplied to the jacket at a pressure of 30 lb. per square inch, this higher pressure being used to prevent the condensation of moisture on the interior of the chamber and also to ensure the steam in the latter being quite dry; there is thus no possibility of wetting the goods in the chamber.

To ensure complete sterilisation of the garments, however, it is not sufficient merely to subject them to the steam pressure, since the air entrained in the

fabric would prevent the steam from thoroughly penetrating the whole of the material. For this reason before admitting steam to the chamber, the air is extracted by means of an ejector capable of producing a vacuum equal to a 20-in. column of mercury. After the alternate application of vacuum and steam pressure has been twice repeated, the vacuum is applied for a third time, and finally warm air is admitted to the chamber by opening a valve connection to an air heater in which the air is passed through tubes surrounded by high-pressure steam. The whole cycle of operations takes about an hour, and when removed the garments, in addition to being completely sterilised are also thoroughly dry and ready for immediate use, even if wet when charged into the disinfector.

The illustrations, Figs. 4 to 6, show the arrangement of the disinfector on the Hood, and, from the plan view, Fig. 6, it will be seen that it is installed in a room 18 ft. 9 in. long and 8 ft. 6 in. wide, divided into two parts by a steel-plate bulkhead. In the left-hand compartment the infected goods are placed in the wire cradle by a sick-bay attendant, who also runs the cradle into the disinfector. After treatment the goods are removed by an engineer artificer in the right-hand compartment, in which the valves controlling the operation of the disinfector are situated. By this arrangement the possibility of the sterilised goods coming into contact with infected articles is entirely avoided, and the artificer operating the apparatus is not exposed to any risk of infection.

As shown in Fig. 4, the disinfector is provided with a cup for holding formalin or other liquid disinfectant, which may be drawn in with the heated air if desired. The fittings also include a recording pressure gauge connected to the chamber, and from the record of this gauge the medical officer can satisfy himself that each batch of goods has been properly treated.

BENCH FOR ANNEALING TESTS OF METALS.

GLASS is annealed for the purpose of removing internal stresses. In the case of metals the term annealing is applied to a thermal treatment that may have two objects, firstly, the removal of internal stress, and, secondly, changes in the structure. The latter object hardly concerns the glass technologists; for changes in the internal structure of glass only take place exceptionally, and when they do, they lead to devitrification and complete uselessness of the specimen. Yet the method of glass annealing which Mr. F. Twyman described before the Society of Glass Technologists in 1917, is immediately applicable also to the problem of removing internal stresses from metal castings. It is a problem in viscosity and is solved by him by means of measurements of viscosity carried out at various temperatures. When we know the variation of viscosity with temperature we can, with the aid of Maxwell's expression for the evanescence of stress in viscous bodies, state the annealing temperature which will remove any desired proportion of the existing stress in any stated time and the determination, we understand, can be effected to a precision of about ± 3 deg. C. The whole determination can be carried out within 2 hours.

The apparatus, which can be obtained from Messrs. Adam Hilger, Limited, 75A, Camden-road, N.W. 1, consists essentially of an electric furnace placed on an optical bench. The specimen is heated to a measured temperature in the furnace, and the observer watches the moment when the specimen, loaded at one end, softens sufficiently to bend under the load. A small strip of the metal of known cross-section is held in a small jig at one end, an arm bearing a weight being attached to the other end. The furnace temperature near the jig is kept under observation by an optical pyrometer. In front of the furnace is a telescope through which the arm is watched; the telescope has a line in the focus of its eyepiece which, by rotation of the telescope about its horizontal axis, can be set parallel with the arm holding the weight; the rotation of the telescope is read off on a divided circle. The temperature is raised slowly and kept constant when yielding commences, the rate of the deflection of the weighted arm being observed in the telescope. From that observation the viscosity can be determined at that temperature. One or two readings having been obtained at other temperatures, a viscosity curve can be drawn, and the proper annealing temperature is deduced from this curve. It is, of course, necessary first of all to define the degree of annealing to be attained and the time in which it is to be attained. With the dimensions of strip recommended a deflection of 2·2 deg. per hour is obtained at the temperature which is suitable for the rapid and perfect annealing of the metal under examination. According to Maxwell,* if a strain B be produced at time 0 in a viscous body, and S be the stress so occasioned, then the stress tends to disappear at a rate depending upon the nature of the body and upon S; and if this rate be proportional to S (as Mr. Twyman found it experimentally to be), and if B be constant at uniform temperature, then $S = E B e^{-t/T}$, where E is the coefficient of elasticity for the strain in question, t the time, and T Maxwell's "time of relaxation"; thus $S = E.T\, dB/dt$. Supposing we find, for a specimen, where S = 56·6 kg. per square centimetre, and $E = 0{\cdot}7 \times 10^6$ kg. per square centimetre, that dB/dt, at 540 deg. C., is 0·0055 hour; then T will be 0·0147 hour or 0·88 minute. Further, if S be the initial stress, the ratio $S/S_0 = e^{-t/T}$, will, for T = 0·88, 1·76, 2·64, 3·52 minutes, have the values 0·368, 0·135, 0·050, 0·018, *i.e.*, after T = 3·52 minutes at 540 deg. C. the original stress will practically have been reduced to zero. The figures given refer to a kind of glass, for which the annealing time T would be halved by an increase of 8 deg. C. in the annealing temperature. The annealing of that glass would, at 556 deg., be complete in less than 2 minutes, but would require 2 days at 80 deg. C. For practical purposes annealing at 540 deg. C. for 3 minutes would hence suffice to remove the stress of this glass; judicious cooling would, of course, have to follow.

The process has been applied notably to the annealing of manganese bronze castings which formerly used to become badly distorted while being machined and subsequently. With the apparatus described it was ascertained in Messrs. Hilger's Research Laboratory that no trouble was experienced when the alloy had been annealed at 400 deg. C. The importance of the continuous control in annealing processes is particularly evident in the case of successive meltings of metals or alloys which should be identical in properties.

* The formula was given in Maxwell's "Dynamical Theory of the Gases," Philosophical Magazine, February, 1868.

THE LATE MR. HAMMERSLEY HEENAN.

WE regret to have to announce the death, which occurred on the 17th inst., at 57, Harrington Gardens, Kensington, S.W. 7, of Mr. Hammersley Heenan, J.P., late chairman and managing director of Messrs. Heenan and Froude, Limited, Manchester and Worcester, a member of the Institution of Mechanical Engineers since 1875, and of the Institution of Civil Engineers since 1876. He was also for some time president of the Manchester Association of Students of the Inst. C.E. For a short period Mr. Heenan represented the Newton Heath Ward on the Manchester City Council, and was engaged on the committee responsible for the civil engineering work of the city.

Mr. Heenan was born at Birr, in Ireland, in 1847; he received his primary education at the Grammar School, Parsons Town, and early in life he evinced great interest in mechanics. He gained the first prize in physical science, given by the late Earl of Ross, who found him to be a student having an exceptionally inventive turn of mind, combined with great practical ability.

In 1864, when 17 years of age, Mr. Heenan went to India in the service of the East Indian Railway, where he worked under his uncle, the late Mr. Robert Heenan, later being engaged by the Public Works Department, on which, in course of time, he was appointed an assistant engineer. He remained for about fifteen years in the Public Works Department, and during that period he was employed on the Northern Railway to the frontier, which was at that time urgently required by the military authorities. Mr. Heenan was then detailed for service in the Bawhlpore State, where, in addition to discharging the usual duties of an executive engineer, he designed the palace now occupied by the ruler of that State. He was ultimately given the appointment of chief engineer to the Public Works Department, but was compelled to decline this, finding that his health did not permit him to remain longer in India.

Mr. Heenan returned to England in 1880, and decided to establish a bridge-building business. He purchased the establishment of Messrs. Woodhouse and Co., Newton Heath, Manchester, and on the retirement of Mr. Woodhouse, he took into partnership a former colleague of his in India, Mr. J. Froude, a son of Mr. William Froude, thus founding the firm of Heenan and Froude, Limited, of whom Mr. Heenan was chairman and managing director until his retirement, two years ago. For some time the firm confined its activities to the designing and building of bridges and structural iron and steel work generally, at the Newton Heath Works, under the supervision of Mr. Heenan, and among the undertakings carried out may be mentioned the Blackpool Tower, and nearly the whole of the bridge work for the London and North-Western Railway, and a considerable amount for the other railways of England. The firm also undertook the whole of the supply and erection of the material for the harbour development of Rangoon, Burmah. The firm extended its business in the late 'eighties, and started engineering works in Birmingham, where it developed many engineering specialities, including the Tower spherical engine. As there was not sufficient accommodation at the Birmingham works, other works were taken at Worcester, where the firm developed the manufacture on a large scale of air filters and coolers, oil and water coolers, refuse destructors, refrigerating machinery and other specialities, the conception and designing of most of which were due almost entirely to the inventive genius of the deceased.

During the war, Mr. Heenan rendered great service to the Government, both in his personal capacity and in applying the resources of the works under his control to the manufacture of munitions. For a number of years he lived at "Uwch-y-Don," Old Colwyn, where he had great pleasure in frequently entertaining his brother engineers. He acted for a long time as magistrate for the County of Denbigh.

INDUSTRIAL NOTES.

THE issue for the current month of *The Industrial League and Council Journal* contains a variety of interesting articles. It opens with one entitled "Are Profits Necessary," contributed by Mr. E. J. P. Benn, C.B.E., who says it makes his blood boil when he sees some Polish Jew land on these shores and within the space of a dozen or twenty years become a millionaire. There is something wrong, he adds, with a system which will keep a highly educated man of science working all his life in comparative poverty and allow an illiterate, vulgar, fat cosmopolitan financier to amass wealth to his heart's content. The capitalist system, the profits system, will not, in his judgment, stand examination from the ethical or Utopian point of view. . . . Morals should exercise an influence over industry, as, indeed, they should influence all our actions. But to substitute morals for actions themselves does not, unfortunately, work out as we should like it to. It does not give us houses, it does not reduce prices; it does not increase supplies and it does not add to our material comforts. . . . Industry and morals are inexplicably mixed up together, but they are not and never will be substitutes for one another. . . . Taxation of all kinds does not, as is commonly supposed, reduce the rate of profits; it merely turns the profit-maker into a tax-collector, and he, very naturally, charges another profit for collecting the taxes. But the commonest fallacy, Mr. Benn further states, is that you can reduce profits by increasing wages, or that wages come out of profits, or profits out of wages. Nothing of the kind is, in fact, true. . . . He, therefore, comes to the conclusion that, in the present state of development of the human race, there is no more chance for platonic industry than there is for platonic love, and he does not want to see civilisation destroyed and the human race reduced to savagery and starvation by the chasing of an ideal which cannot apply to mere mortals. If, instead of endeavouring to exterminate the profiteer, he were encouraged (the British born profiteer, we presume), there would be so much competition among profit-makers as to reduce profits to an economic level. That, according to Mr. Benn, is the business-like thing to do.

Messrs. Rashleigh Phipps and Co., Limited, electrical engineers, 147, Oxford-street, W., have sent us particulars of their investment scheme. The share capital of the company is 50,000*l.*, divided into 50,000 shares of 1*l.* each. Of these, 5,000 are employees' shares and 45,000 are ordinary shares. The issued capital is 23,000*l.*, divided into 2,000 employees' shares and 21,000 ordinary shares. The dividends are paid in the following order: First payment, 6 per cent. per annum on employees' shares; second payment, 6 per cent. per annum on ordinary shares; third payment, the surplus, after the above payments, is divided among members holding employees' shares and members holding ordinary shares in proportion to the capital paid-up on the employees' and ordinary shares held by them respectively. The dividend on employees' shares has first claim and is paid out by the company before any other dividend is paid. In the event of a bad year, and if the 6 per cent. on employees' shares could not be paid, the latter would attain a cumulative value; *i.e.*, the money would be paid in the following year before any other dividends were paid. The purchase of shares by employees is either by direct payment of 1*l.* or multiples of 1*l.*, or by instalments. The particulars from which we quote deal with various eventualities and give examples of dividend distribution.

The Ministry of Transport, in an announcement issued last week, state that the Cabinet have had under consideration the recent report of the National Wages Board on the wages claim of the railwaymen, and have been deeply impressed by certain passages in the report. (We gave an abstract of this report on page 789 *ante*.) The announcement quotes paragraphs indicating that the claims had as their basis a desire

to improve the pre-war status of the railway workers, and also says that, while large increases in charges to users of the railways are necessary, it must be borne in mind that somewhere a point is reached at which an increase in rates must lead to such a displacement or arrestment of traffic as will result in loss instead of gain.

This point of view, the announcement adds, impressed the Cabinet profoundly, and, in deciding to direct the railway companies to give effect to the award, they call attention to the Board's view that the settlement should not be disturbed for such a period as will facilitate a return to the stability of industry and commerce. In the opinion of the Cabinet, this must be accepted with a qualification, and, should the forthcoming increase of railway rates and charges not produce additional income, it would be impossible for the present level of wages to be maintained. In such circumstances, the improved standard of remuneration of railwaymen, which the Government desire, if possible, to maintain, can only be maintained by the hearty co-operation of the workers with the management, enabling such substantial economies in working to be effected as will adjust any adverse balance.

The Cabinet have decided to extend to Ireland in principle the findings of the Board, and to increase wages on the Irish railways by similar percentages to those given in Great Britain.

We have received from the Board of Trade (Coal Mines Department) a statistical summary of output, costs, &c., of the coal-mining industry, in respect of the three months ended March 31 last. The total tonnage raised in Great Britain during the quarter was 62,057,000 tons; the tonnage disposable commercially was 55,680,878 tons, after deduction of 6,376,122 tons for mine consumption and miners' coal. Of the 55,680,878 tons, 11,711,162 tons were shipped for export and foreign bunkers, mainly from South Wales, Monmouthshire, Northumberland and Durham. The total net cost of production was 81,882,839*l.*, or an average of 29*s.* 4·94*d.* per ton. This total includes a wages bill of 63,220,756*l.*, or 22*s.* 8·50*d.* per ton (the recent advance in wages operated from March 12). Stores and timber cost 12,758,171*l.*, or 4*s.* 6·99*d.* per ton. Other costs (management, salaries, &c.) were 4,560,566*l.*, or 1*s.* 7·70*d.* per ton. Royalties amounted to 1,747,653*l.*, or 7·53*d.* per ton. The coal disposed of commercially yielded 96,260,541*l.*, or 34*s.* 6·91*d.* per ton, leaving a balance on the credit side of 14,377,702*l.*, out of which provision has to be made for depreciation, interest on debentures and other loans, capital adjustments under Finance Acts, and the profit to which the owners are entitled under the Coal Mines (Emergency) Act, 1920. The number of workpeople employed was 1,168,659; the tonnage raised per person employed amounted to 53·10 tons, the average earnings per person employed being 54*l.* 1*s.* 11*d.* The summary from which we take these data gives the figures for each mining district separately.

Speaking last week at the meeting of shareholders of the Ebbw Vale Steel, Iron and Coal Company, Limited, the chairman, Mr. Frederick Mills, said, "Whilst it is no longer possible for the workman to become individually the owner of the machinery he works with, it is possible for him to become his own capitalist, and it is because I am firmly convinced that it is by that means, and by that means alone that labour unrest can best be ended, that I venture to point out how it can be done. A year ago in my evidence before the Coal Commission, I calculated that the control of this company could be secured by each employee investing 72*l.* in the shares of the company (taken at par value). To-day, it would cost each of the 34,000 workmen now employed 29*l.* 5*s.* 3*d.* to do so. Am I to be told that such an investment is not possible? The list of our 10,000 shareholders shows that many of them are men and women of small means, and I suggest that if 10,000 such people can control our company, then 34,000 of our own men could do the like. I agree at once that the actual process of acquiring shares in industrial concerns is at present too mysterious for the general body of workpeople. Here then is a chance for amendment. One of my colleagues has suggested that shares should be as readily obtainable as war securities, of which there are many millions of holders. I am convinced if that could be done there would be as many shareholders as there are workpeople. Once let them taste the advantages of possessing the capital that enables them to work, we should soon see a change in the anti-capitalistic attitude we all deplore. . . ."

In Parliament last Monday, Colonel Newman asked Dr. Macnamara, Minister of Labour, whether the National Union of Gas Workers had decided in favour of an immediate general strike, involving over 1,000 municipal and private undertakings; whether he was aware of the determination of the general public that this essential public service should be carried on by voluntary effort should the union refuse to submit its case to arbitration, and what steps did he propose to take. Dr. Macnamara replied that in connection with claims for an advance of wages and certain rearrangements in regard to overtime rates, week-end payments and holidays, the unions connected with the National Federation of General Workers had recently taken a ballot on the question of a stoppage of work to secure their claims. This ballot, the results of which were declared on June 3, showed a large majority in favour of a stoppage of work, and accordingly notices had been tendered, and will expire on Saturday, June 26. The Ministry of Labour had been in close touch with the representatives of the employers and with the representatives of the unions during the last few days. He regretted that, so far, no settlement had been reached. His department had remained in touch with the two sides; he was fully aware of the importance of the dispute, and would lose no opportunity of utilising to the full the services and powers of his department in an endeavour to effect a settlement.

The first annual report of the Industrial Fatigue Research Board, to March 31, 1920, recently issued at the price of 6*d.* net, from H.M. Stationery Office, gives an account of the work of the Board down to that date. It states that the scientific study of the laws governing the healthy employment of the human mind and body in industry was strangely late in its development in this country, although it was in Great Britain that the industrial revolution had its first beginnings and industrial development was most rapid; and also that geographical, social and political conditions combined to intensify the evils arising from the neglect of scientific study. Dealing with reduction of hours, the report says it was not until 1893 that Messrs. Mather and Platt, Manchester, conducted their well-known pioneer experiment on the subject. Mr. Mather, later Sir William Mather, to whose initiative this work was due, primarily endeavoured to show that "work before breakfast" was open to economic as well as to social objections. The working day, accordingly, during the two years' experimental period was shortened, work beginning at 8 a.m. instead of 6 a.m. The experiment showed that the reduction in hours from 54 to 48 a week caused an increase in production and a decrease in lost time. The results gained by Messrs. Mather and Platt did not, however, lead to any general adoption by engineering or other firms of any analogous methods or to any organised scientific study of the subject either by Government or by private firms.

The annual report continues as follows: The Board recognised at the outset that the problem of industrial fatigue could only be successfully attacked on two simultaneous lines of research, the one medical and the other industrial. Up to the present seven reports have been published. In addition, certain memoranda dealing with matters of scientific rather than general interest have been submitted by investigators; the Board feel that these would appear more appropriately in a scientific journal than as part of the series of their own reports, and the investigators concerned have been authorised to publish them accordingly.

The Ministry of Labour state that employment in May continued good on the whole. The percentage unemployed among workpeople (skilled and unskilled) covered by the Unemployment Insurance Acts was 2·68 on May 28, as compared with 2·80 on April 30, and the percentage unemployed among the members of certain trade unions (mainly of skilled workpeople) from which statistics are obtained was 1·1, as compared with 0·9 in April and 2·1 in May, 1919. The number of men and women on the live registers of the Employment Exchanges was 304,907 on May 28, compared with 325,915 on April 30. In most of the principal industries employment continued good, but in the leather and boot and shoe trades it showed a decided decline, and much short time was worked. There was also a decline in the weaving section of the cotton trade, and the slackness in the Irish linen trade continued.

The number of trade disputes beginning in May was 204. In addition, 80 disputes which began before May were still in progress at the beginning of the month. The total number of workpeople directly or indirectly involved in all these disputes, new or old, was about 138,000, as compared with about 140,000 in the previous month and about 105,000 in May, 1919. The estimated aggregate duration of all the disputes during the month was nearly 1,169,000 working days, as compared with 880,000 days in April, 1920, and 673,000 days in May, 1919.

In the industries for which statistics are available, changes in rates of wages reported to the department as having been arranged to come into operation in May, with effect either from that month or from earlier dates, resulted in a total increase of over 750,000*l.* in the weekly wages of nearly 1,700,000 workpeople. The principal changes affected building trade operatives, whose wages were raised during May in all the principal towns in England and Wales, cotton operatives in Lancashire, woollen and worsted operatives in Yorkshire, and dock labourers at all the ports. Changes in hours of labour affected over 250,000 workpeople, whose normal weekly working time was reduced by an average of about 2½ hours.

The average level of retail prices (including food, clothing, fuel and light, &c., as well as rents) on June 1, as indicated by the statistics prepared by the Ministry of Labour, was about 150 per cent. above the level of July, 1914. For food alone the average increase was 155 per cent. These statistics relate to commodities of pre-war working class consumption, and the same quantities and, so far as possible, the same qualities of each article are taken at the present time as before the war.

Early last week, a strike of marine wireless operators was declared by the Association of Wireless Telegraphists, which represents 4,500 wireless operators. The association demands a minimum wage of 2*l.* 16*s.* per week for qualified men, rising to 7*l.* 14*s.* per week after nine years' service. It claims that its members number 95 per cent. of British marine wireless operators. When the trouble broke out, the Marconi Company stated that the whole staff was under an agreement; that there were over 1,000 men who had not completed their first twelve months' service and had no right to leave the company under twelve months. The company taught the men and incurred considerable expense in their instruction, and the contract with them was that in consideration for the expense incurred they should serve the company for one year; the company would hold them to the terms of their agreement. The remaining men were under an agreement subject to four weeks' notice on either side, and the company looked to them to carry out these terms. The matter was placed in the hands of the Engineering Employers' Federation; the latter notified the association that the operators must resume work before wage negotiations could be opened. Mr. Godfrey Isaacs, managing director of the Marconi Company, referred to the dispute at the annual meeting of the company last Friday, and said that the operators' demands, if acceded to, would represent an annual payment of about 500,000*l.*; it would be impossible, he added, to concede these demands without the approval and authority of the shipowners. It was reported last week that the Board of Trade had notified shipowners that, during the strike, owners of vessels of over 1,600 tons register would not be proceeded against for a breach of the regulations by sending such vessels to sea without operators. Last Tuesday, a meeting was held in Liverpool of societies affiliated with the Seafarers' Joint Council, when it was resolved that they should give full support to the wireless operators. The societies strongly condemned the action of the Board of Trade in intervening in the dispute on the side of the employers; the members of these societies were advised not to sign on any ship on which a wireless operator other than a member of the Wireless Officers' Association was engaged, or from which the operator had been withdrawn in accordance with the decision of the Board of Trade. As a result of the dispute and of the "sympathetic" action of other unions, British shipping is becoming gradually more disorganised. At the time of our going to Press it is reported that the marine wireless operators have been instructed by their association to proceed to sea pending a conference between the Marconi Company, the Shipowners, the Association of Wireless Telegraphists and the Seafarers' Council.

THE DETERMINATION OF THE LOADS ON CRANE WHEELS.

To the Editor of Engineering.

Sir,—I thank Mr. E. L. Montagnon for his suggestion of the analogy of the short column eccentrically loaded, for I think this will enable me to put my case in a nutshell.

If the column is of elastic material and the load is applied eccentrically through a rigid, inelastic cap, bearing flat on the top of the column, then the axle springs of a spring-borne crane may be compared to the column and a rigid carriage frame to the cap. But if the crane is not spring borne the springiness of the crane carriage usually becomes of major importance, and it is like an elastic cap bearing on top of a rigid, inelastic column, when of course the stresses will be quite different. Mr. Montagnon in his article has given us a useful and accurate analysis of the problem of the spring-borne crane, but he has rather spoilt it by such statements as, "the wheel loads found above may be taken to apply whether the crane is or is not mounted on springs."

With regard to Mr. Montagnon's plea that in view of the indeterminate nature of the problem his rules have as close a degree of accuracy as possible, I submit that the older rule of taking the weight of the revolving part to the carriage sides along a line running across the

carriage at right angles to the track and then distributing among the rail wheels for each side separately, is more accurate in an overwhelming majority of cases of cranes without axle springs. The centres of gravity of the reactions of the two rails as given by Mr. Montagnon's methods do not lie perpendicularly opposite one another, while the cross-girders of crane carriages usually are at right angles to the direction of the track, and might be expected to take their loads straight across the carriage, as assumed in the older method.

In the case of the crane of bridge type (portal or underhung) with revolving part mounted near one end of the bridge, the older method assumes that the moment tending to twist the bridge when the jib is parallel to the track will be divided between the two ends of the bridge in inverse proportion to their lengths, so that the short end, being stiffer, will take the bigger share of the twisting moment. This seems more reasonable than the assumption involved in Mr. Montagnon's rules, that half the twisting moment will be transmitted to each end of the bridge. In this connection Mr. Montagnon says I appear to have overlooked another moment at right angles to the moment twisting the bridge. I am a practical crane designer and had certainly not forgotten the other moment, but I imagine there can be no difference of opinion as to how that moment is taken; in any case I fail to see how its presence affects the validity of my argument.

I quite agree with Mr. Montagnon that a four-wheeled crane would not stand for long on two diagonally opposite wheels only. That would be a case of unstable equilibrium, and the crane would tilt over until steadied by a light pressure on another wheel. With this in view I wrote "*practically* the whole load might come on two diagonally opposite wheels." I apologise to Mr. Montagnon for not explicitly mentioning the third wheel, but point out that if a few hundredweights or even a ton or two should fall on that wheel the validity of my argument remains unaffected.

Yours faithfully,
W. W. PADFIELD.

2, Cedar Villas, Bath, June 19, 1920.

"COLLISION DYNAMICS."

TO THE EDITOR OF ENGINEERING.

SIR,—I am gratified to see from his letter to you of the 14th inst. that Sir George Greenhill confirms the mathematical soundness of the law of dynamics I propounded in my letter of the 4th, although he intimates that (whereas I had laboriously to work it out from first principles) it was already known, to the few mathematicians of his high order, by implication from this or as a corollary of that, and so was not worth stating at length.

Seeing, however, that the law provides a key to a fund of practical information on external ballistics that artillerists have long been in want of, and that it had not been put at their disposal by the professional mathematicians, I submit that the "necessity" referred to in Sir George's mediæval latin quotation existed, and that it was well worth while that attention should be drawn to the law even by a humble practical engineer.

With regard to "Mechanic's" criticism, that one must not talk of energy being "expended" because, by the law of conservation of energy, it cannot be destroyed, I am not in agreement. I agree that energy in a mathematical sense means capacity for performing work. In the same sense a shilling means capacity for buying a shillingsworth; but if I buy a shillingsworth of eggs at a grocer's am I to be told that I have not "expended" the shilling because I have not destroyed its capacity for buying, which still remains unimpaired (though now in the grocer's hands instead of mine)?

A shell in flight striking an armour plate is endowed with energy, i.e., with capacity for performing work. After passing through the plate its energy is less, because it has performed some of the work it was before capable of, and in so doing has exhausted (used up, expended, converted, &c.) or parted with some of its initial energy. The energy it has parted with has not been destroyed *vis-a-vis* the universe, but the shell has most certainly expended it out of its previous store derived from the gun.

Yours faithfully,
T. J. TRESIDDER.

8, The Sanctuary, Westminster, June 22, 1920.

AMERICAN TEXTILE PRODUCTS IN ARGENTINA.—According to the United States Commissioner in the Argentine Republic, the exports to that country of textiles increased 50-fold between 1913 and 1918. Taking advantage of the exceptional conditions brought about by the war, manufacturers of these articles in the United States sold to the Argentine market 18,814,000 dols. worth in the fiscal year preceding the armistice, as compared with 312,000 dols. only in the year before the outbreak of hostilities.

CATALOGUES IN FOREIGN LANGUAGES.—An example of the enterprise of certain foreign firms is shown in the activities of a well-known Italian electrical and general engineering concern, who have decided, says *The Board of Trade Journal*, to issue catalogues, &c., printed in French, Spanish, Portuguese and Italian, descriptive of their leading products. It is also proposed to publish and distribute catalogues, in the languages of Greece, Serbia, Bulgaria, Russia, Brazil and Palestine. It is intended to distribute these among all electricity supply authorities and power stations in the said countries.

NAVAL ARCHITECTURE IN AERONAUTICS.*

By JEROME C. HUNSAKER, Eng.D., Commander, Construction Corps, U.S. Navy.

Introductory.—As an American, I am very pleased to have been asked to read the Wilbur Wright Lecture for this year, and for a moment to stand in the reflected glory of my eminent countryman. Wilbur and Orville Wright were the pioneers who blazed the trail, and made the first clearing in the wilderness. We engineers who follow later are only applying modern machinery and methods of intensive cultivation in their original field. We should, therefore, keep in mind the fact that this field is given to us in trust to keep fertile, that its yield of benefit to mankind shall not diminish. I have chosen to discuss the use of the tools of the naval architect in aeronautics, as I consider that the time has now come to use them. The naval architect is a craftsman with both artistic and scientific traditions, and the art he practises has a technique perfected by the experience of generations. It is only a few years since the Wrights gave the aeroplane to the world, but four of those years were years of astonishing activity, and the experience of those years is worth more than that of forty ordinary years. There is already a vast store of experience available which the naval architect's methods can analyse, classify and reduce to useful engineering terms.

While aeronautics as a useful art and a science is new, naval architecture is hoary with age. Noah probably considered and evidently reached a successful solution of the very problem of animal transport by sea that confronted our naval architects in the Great War. King Hiram of Tyre must have had a very fair naval architect who could fashion ships from cedar of Lebanon with a factor of safety and a range of stability adequate to cope with Atlantic storm waves. Archimedes, however, is generally recognised as the father of naval architecture. He first developed the laws of displacement and buoyancy, and is credited with the construction in 264 B.C. of the Syracusia of 6,000 tons—a veritable Dreadnought of antiquity.

The naval architect practises an art with scientific methods. He applies mathematics, especially geometry, in establishing lines, displacement and stability. He applies the methods of the civil engineer in matters of structural design. In matters of resistance and propulsion he is guided by the theory of hydrodynamics. But in all of these applications, the sure and true guide has been experience. From that remote age when the hollowed-out log canoe replaced the solid tree trunk down to the days of sail and steam, the naval architect has based his new design upon his last. Factors of safety and coefficients of all kinds, used in apparently theoretical or frankly empirical formulæ, have been really factors of experience. The naval architect's problem deals with the sea, and we cannot pretend to know much more of its mysteries than that Syrian landsman who marvelled at the way of a ship in the midst of the sea. The forces of nature are still incalculable, but the design of a vessel to be staunch and safe is not such a dark and dreadful adventure. Confidence comes from experience and the naval architect's most powerful assistance comes from the scientific analysis of that experience to reduce its lessons to engineering terms.

The naval architect has available a priceless store of learning accumulated by generations of shipbuilders which, with skill and judgment, he can make serve him. He cannot afford to lean too heavily on the past, however, and where a new type of vessel must be produced, imagination and judgment of a high order are necessary. There is an artistic side to naval architecture, and for many craft the artistic feeling or "flair" of the designer distinguishes an advance in the art from a routine product. In aeronautics I have yet to see a design representing a marked advance in the art made either without this artistic feeling for form and proportion or made wholly without reference to the lessons of the past.

General comparisons are impossible, but it seems to me that in England aircraft designers have followed the naval architect's methods more than in other countries. This is, perhaps, natural in the first maritime power of the world. In England, also, I find a very extensive application of the results of experimental research, both model and full scale, which really is experience interpreted and analysed by scientific methods. In France I see less influence of experience and perhaps more originality of invention as shown by occasional radical departures, omitting intermediate steps of development. In Germany there was once a tendency to "professorial designs" based too strictly on theory, resulting in strange and awkward structures like the Taube types. During the war something happened to reverse this policy, and we saw a series of machines developed step by step, obviously from experience. In America we have suffered from the designs of the inventor without experience and from the practical rule-of-thumb man without theoretical landmarks to guide him. On the whole, the successful designs have been produced by men of imagination and judgment applying analysed experience with the best theoretical and engineering information available.

For very small machines the inventor type of designer has been very successful at odd times. He hits on a good solution, and, by a process of cut and try, eventually works out the faults before his patience or purse is exhausted. For large machines and airships the time and expense required are too great for cut and try methods. A large flying boat or an airship is a success or failure on her first flight. If badly over weight, unstable or out of balance there is no chance to rebuild.

In our Navy we look with suspicion on the man who is more concerned with the method of doing things than in the actual doing of them, and to avoid any misunderstanding, I must say here that I wish to make my point as to the utility of the naval architect's methods in aeronautical engineering by attempting actually to do a few things which appear to be needed at this time. This work I have thrown into appendices attached to this paper. I will not take time to read each complete appendix, but will discuss them briefly. I trust that if my technical friends will find time to look into them, they will find them useful.

* Wilbur Wright Lecture, Royal Aeronautical Society. Delivered on June 22 at the Central Hall, Westminster.

ABSTRACT OF APPENDIX I.

Weight Estimation.—Both the aeronautical engineer and the naval architect risk their reputations with weight estimates. A ship must float on her designed water line and an aeroplane must fly with the wing surface provided. Serious overweight in either case marks a failure. It is only rarely that vessels are discovered to be much overweight, but, unfortunately, overweight has been all too common with aircraft. Naval architects are able to estimate weight with fair precision from unit weights gleaned from past experience, and to check this estimate by calculation from the drawings. During construction, weights are controlled by weighing everything that goes aboard the ship. For aircraft, the practice of rigid weight control has not been well established either in the shop or in the drawing office. Very often construction is commenced before the drawings are completed, and during construction changes and alterations are incorporated without reference to their cumulative effect on the weight. A proposed change may be approved on its merit and not with reference to a definite weight allowance.

It is essential that before construction, or even detail design, is commenced, a weight estimate should be made in the nature of a weight allowance which shall be treated like a bank balance, and on no account be overdrawn. Such a weight allowance must be made from the general design drawings before the details are developed and necessarily is based on past experience with a similar type of construction. This is the naval architect's method, and to avoid guesswork requires extensive records and weight returns from actual work. The matter of weight estimation for various types of aeroplanes is not really such an inaccurate procedure even in the case of an apparently radical departure from previous types of construction. I have assembled published weight data for several hundred different aeroplanes and seaplanes—British, French, Italian, German and American—from the smallest to the largest, and while the returns in any individual case may be unreliable, the general trend is usually quite definite. It appears that no designer, whether using solid wood, hollow wood or metal, is getting something for nothing, and, in general, the percentage weights for machines of similar type are remarkably alike. If this conclusion be established, a designer may estimate the weights of a new design with some degree of confidence provided he has data for a somewhat similar type to work from.

The following general conclusions appear to be established:—

1. The weight of wings, struts, wires and tail surfaces amounts to about 20 per cent. of the gross weight for all types.

2. The weight of body, fuselage, landing gear, boat hull, &c., trends downward from 22 per cent. of gross for 1-ton machines to 15 per cent. of gross for 20-ton machines.

3. The weight of power plant also trends downward from 30 per cent. for small to 20 per cent. for large machines.

4. The weight light for machines from the smallest to the very maximum sizes has to-day a lower limit at about 53 per cent.

5. For large flying boats and large aeroplanes the weight light is about the same.

6. The structural weight is high for low-powdered machines and low for high-powered machines, and in general the best weight carriers show about 18 lb. per horse-power.

7. Similarly, the structural weight is high for low wing loading and *vice versa*.

8. The wing loading is found to be greater for the larger machines, reaching a maximum of nearly 12 lb. per square foot for the large flying boats.

9. It appears that all the evidence from past practice indicates that large flying boats can safely be given a higher wing loading and a higher landing speed than land aeroplanes, and, hence, have a distinct advantage as weight carriers for commercial purposes.

ABSTRACT OF APPENDIX II.

Metacentric Height.—They that go down to the sea in ships are wont to criticise a ship in an offhand manner, her wetness or dryness, her period of roll, whether she will sail sweetly or prove crank, and other mysterious details of her intimate behaviour among waves. And all this with an apparent confidence which to a layman must betoken a wisdom such as Solomon's. But there really is little mystery about it, for nearly 175 years ago, Bouguer,* the father of theoretical naval architecture, hit upon the brilliant conception of a metacentric height to serve as a measure of stability. Since that time

* Bouguer, "Traité du navire," Paris, 1746; L. Euler, "Scientia Navalis," St. Petersburg, 1749; Atwood, "Stability of Ships," London, 1796; Chas. Dupin, "Applications de Géometrie et de Mécanique à la Marine," Paris, 1822; P. J. Moreau, "Principes fondamentaux de l'équilibre," &c., Lorient, 1830; J. M. C. Duhamel, "La stabilité des corps flottants," Paris, 1832; H. Mosley, "On the Dynamical Stability and on the Oscillations of Floating Bodies," London, 1874.; F. K. Barnes, "On the Metacentre and Metacentric Curves," "Naval Science," vol. iii, London, 1850; E. J. Reed, "A Treatise on the Stability of Ships," London, 1885.

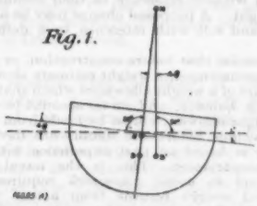
thousands of ships have gone to sea with cargoes stowed in an indefinite number of arrangements, and millions of passengers, as well as animals, have been made violently or only mildly ill. Some ships carried sail well, others were crank; some ships proved stiff but violent in motion, others capsized. Every sort of marine disaster has occurred, and as a result an enormous store of experience has been accumulated. In nearly all such cases a knowledge of the metacentric height of the vessel has proved to be a valuable index to her behaviour.

The metacentric height or distance from the centre of gravity to the metacentre is the limit of the distance G m on Fig. 1 as the angle of roll $\Delta\theta$ from the normal or upright position becomes small. A ship is stable if there is a righting moment for any angle of heel. The initial stability is measured by the metacentric height in the upright position. If the ship be already heeled through a large angle, she is still stable if she still has a positive metacentric height. There is thus to be considered the problem of range of stability or the angle of heel permissible before the metacentric height vanishes. The period of a roll, neglecting damping, is given by the expression:

$t = \pi k / \sqrt{(g \cdot G m)}$, where k is the radius of gyration.

It appears that the rolling will be quick, and hence uncomfortable, when G m is large. For an easy ship

Fig. 1.



W = total weight. L, L′ = water-lines upright and inclined. B, B′ = centres of buoyancy upright and inclined. $\Delta\theta$ = angle of inclination. M = metacentre. G = centre of gravity. Gm = metacentric height.

Righting moment = W Gm sin $\Delta\theta$ = W . Gm . $\Delta\theta$.

G m should be small, but not so small as to impair the range of stability. For passenger steamers G m may be made small with safety, but for warships it is necessary to provide a larger G m than the gunnery officers would desire, to provide for stability in a damaged condition. Battleships sunk in action usually capsize before going under. I have spoken so far of the "lateral" metacentre which controls the rolling of vessels. There is, of course, a strictly analogous "longitudinal" metacentre which controls the pitching.

The metacentric height is, of course, an index to the statical condition only, but for all practical purposes has served the naval architect very well. The dynamics of rolling among waves* are even more elusive than the theory of aeroplane stability so beautifully developed by Bryan† and Bairstow.‡ And just as the naval architect proceeds to design good vessels by using his practical judgment based on experience and a knowledge of the metacentric height regardless of the mathematics of resisted and synchronous rolling, so do we find aeroplane designers producing good aeroplanes, using practical judgment and very little mathematics. I have yet to find anyone in a successful aeroplane design office solving simultaneous differential equations of motion.

Unfortunately, the aeroplane designer has not 100 years of experience to draw on, and there has been no ready handle on an aeroplane to seize upon like a metacentric height. Consequently, a great deal must be left to judgment, artistic feeling, comparison with other aeroplanes, and eventually to the opinion or prejudice of the test pilot. The need for some ready means for off-hand judgment of aeroplane stability and manœuvring ability has been felt for a long time. The mathematics of stability are too cumbersome for practical use, and require extensive wind-tunnel research to establish the necessary constants. It is my experience that we can build and fly a small aeroplane in less time than it takes to perform the stability calculations.

The general case of the disturbed motion of an aeroplane is not simple, but the longitudinal or symmetrical motion is two-dimensional and can be considered apart from the lateral or asymmetric motion. For the longitudinal motion, we are interested in the pitching oscillations and the criterion that such oscillations be stable. For aeroplanes of normal design, if there be a righting moment called into play by any angular deviation from the normal attitude,§ the pitching oscillations so produced are strongly damped. In other words, if an aeroplane be statically stable it is also dynamically stable, so far as pitching is concerned.‖

My colleague, Commander Wm. McEntee (C.C.), United States Navy, suggested the application of the naval architect's metacentre to measure the statical stiffness of an aeroplane's longitudinal stability. I have assembled the data from all of the wind tunnel tests on complete model aeroplanes that I had available, and have computed the metacentric height from the observed slope of the curve of pitching moments in the following manner:—

$\Delta M/\Delta\theta$ = slope of curve of pitching moment.

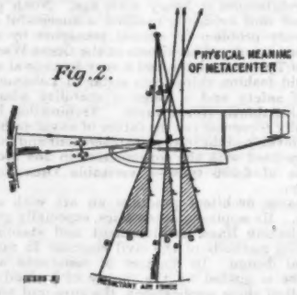
And $M = W \cdot G m \sin\theta = W G m \theta$, for small angles.

But $M = (\Delta M/\Delta\theta)\theta$.

Then $G m = (1/W)(\Delta M/\Delta\theta)$.

This algebraic definition of G m has the dimensions of a length and amounts to from 2 ft. to 12 ft. for modern aeroplanes and flying boats. It is directly proportional to the coefficient M_w of Bairstow's notation, but immensely more easy to remember for use for purposes of comparison. It is also proportional to the centre of pressure motion. To give the length G m a physical meaning, Fig. 2, has been drawn to an exaggerated scale. It will be noted that m is the intersection of resultant lift vectors for successive angles of incidence, resolving the lift component at a line of reference through the centre of gravity in the direction of motion. As an intersection,

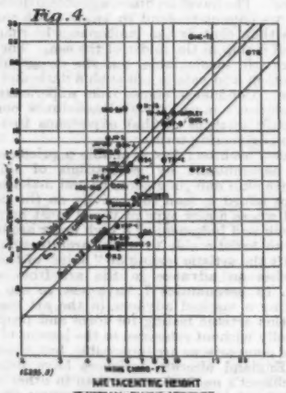
Fig. 2.



L = lift = weight = W. D = total drag. R = total air force. G = centre of gravity. ⊙ = centre of pressure. M = metacentre. Gm = metacentric height. $\Delta\theta$ increment of pitch.

Pitching moment = W . Gm . sin $(\Delta\theta)$, = W . Gm . $\Delta\theta$.

Fig. 4.



m is, therefore, dependent on the angle of incidence, and it can be shown that for large angles of incidence m approaches G. The metacentric height grows less and tends to vanish when the aeroplane stalls. This is, of course, entirely consistent with the unfortunate natural phenomenon which makes a stalled aeroplane notoriously unstable.

Fig. 3 is a graphical representation of a wind tunnel test of a model of a flying boat. It shows how G m diminishes for larger angles of incidence until it vanishes at about 12 deg. The metacentric heights have been calculated from wind tunnel tests on complete models (ex propellers) of 27 types. Aeroplanes both small and large were included, as well as float seaplanes and flying boats. We have a truly miscellaneous collection, with British, French, German and American examples, which should give a good test of the naval architect's method of classification by means of metacentric height. Designers have, in general, been giving a greater metacentric height for great chord length, which appears reasonable. Plotting the metacentric height against chord length on Fig. 4 brings this out clearly. The points group themselves about a straight line. It therefore seems possible from a knowledge of the relation of chord to metacentric height for any design to say, with some confidence, whether the machine will be more or less stable (stiff) longitudinally than the average, and whether such stability will be reasonable or abnormal.

Effect of Change in Angle of Stabiliser Setting.—Calculations of G m have also been made from wind tunnel tests in which the setting of the stabiliser has been altered. To bring out the effect of such changes, Fig. 5 has been made where G m is plotted against the angle of stabiliser setting, *i.e.*, the angle between the stabiliser and the wing chord. It will be noted that the points fall near straight lines whose slopes are the change in G m per degree change in angle of stabiliser setting. This slope is denoted by $\Delta G m/\Delta\beta$ and is plotted against the ratio of horizontal tail area/to wing area in Fig. 6. It is found that $\Delta G m/\Delta\beta$ depends on the area of the horizontal tail surfaces in a straight line function. The slope of each line of Fig. 5, when plotted on Fig. 6, falls near either one or the other of two straight lines which have substantially the same slope. It is to be noted from these lines that the tractor-type tail surface is less efficient than the N.C., a pusher-type tail surface, a conclusion consistent with previous experimental work. (A. C. A. R. and M. 438 and 505.)

Effect of Change in Stabiliser Area.—The values of G m for changes in stabiliser area for various machines, plotted against percentage of the original area, are given in Fig. 7, and it will be seen that they line near straight lines. The variation in the slopes of these lines is small and seems to be independent of the original size of the stabiliser.

Fore and Aft Movement of Centre of Pressure.—In order to study the movement of the centre of pressure, the 4 deg. vector location, or line of action of total air force for an angle of incidence of 4 deg., has been determined for a number of machines and for various stabiliser settings. These locations are plotted on Fig. 8. For

Fig. 3.

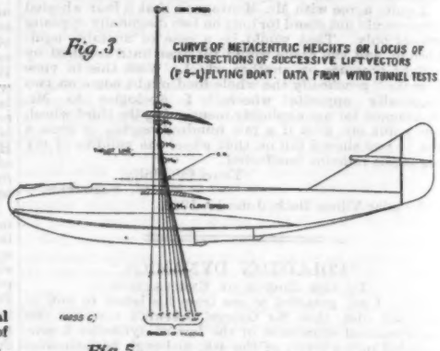
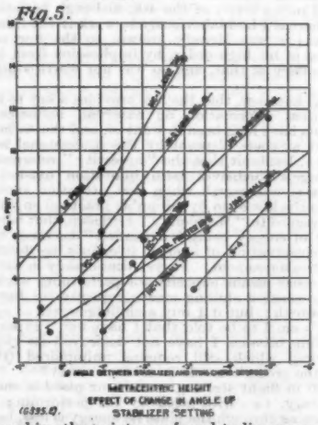

CURVE OF METACENTRIC HEIGHTS OR LOCUS OF INTERSECTIONS OF SUCCESSIVE LIFT VECTORS
(F 5-L) FLYING BOAT. DATA FROM WIND TUNNEL TESTS

Fig. 5.



each machine the points are found to lie near a straight line, the line for the larger machines having, however, a greater slope than those for the smaller machines. In Fig. 9 the slopes from the lines of Fig. 8 are plotted against the wing chord of the machines which they represent. The fact that all of the points so plotted lie very nearly on a straight line indicates that the movement of the 4 deg. vector with change in angle of stabiliser setting is almost entirely dependent upon the wing chord. The average value of the movement of the 4 deg. vector per degree change in stabiliser setting is found to be 0·033 × chord. This movement is forward if the normally negative angle between stabiliser and wing chord is increased, and *vice versa*.

In the foregoing discussion I have tried to bring out the fact that an aeroplane actually has a metacentric height which is entirely under the control of the designer. It would very much clarify our knowledge of aeroplanes if we knew the initial metacentric height the designer gave it. Knowing this, we could judge, with some degree of confidence, whether the machine is reasonably stable for its type. Further, if we knew the metacentric height as designed, the effect of stabiliser adjustment could be considered more intelligently than it is at present. The adjustable stabiliser is a very useful and convenient device for altering the balance of a machine, but it also alters the metacentric height. It is quite possible, by excessive use of this means to balance up an otherwise tail heavy machine, entirely to destroy the metacentric height and hence the stability. The tables and charts given in the complete appendix may prove useful in the consideration of such a possibility for a particular design.

Abstract of Appendix III.

Control Surfaces.—I doubt if there is any one part of an aeroplane which has caused more trouble than the control surfaces: rudders, elevators, ailerons. The three-rudder system of control invented and developed

---

* D. Bernoulli (Prix de l'Académie des Sciences), Paris, 1757; Dupuy de Lôme, "Mem. G.M.," vol. iv., Paris, 1859; Wm. Froude, Proc. Inst. Nav. Arch., vols. ii, iii, iv, xiv, xvi, London; Rankine, Proc. Inst. Nav. Arch., vols. v, xii, London; Scott Russel, Proc. Inst. Nav. Arch., vol. iv, London; Bertin, "Les vagues et le roulis," Berger-Levrault, Paris, 1877; Reech, "Théorie du roulis, &c.," Paris, 1870.

† G. H. Bryan, "Stability in Aviation," Macmillan, London, 1911.

‡ L. Bairstow, "Advisory Committee for Aeronautics," R. and M., 116–122, London, 1914.

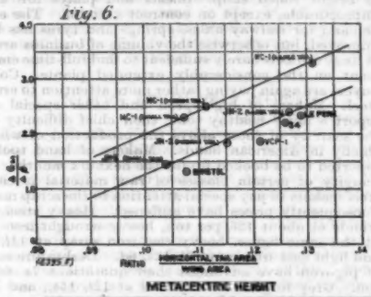
§ A positive value of M_w in Bairstow's notation.

‖ Hunsaker, "Dynamical Stability of Aeroplanes," Smithsonian Misc. Coll., vol. lxii, No. 5.

by the Wrights made flight possible. It is fundamental for three dimensional space. All of the experiments before the Wrights failed for lack of proper control. Consider the machines which did not really fly of Lilienthal, Montgomery, Langley and the other pioneers. As soon as the Wrights showed how to control an aeroplane, any boy could make his own glider. Yet, although the fundamental nature of this discovery is universally recognised, we know little more about the design of such control surfaces than the Wrights taught. Control surfaces are proportioned for aeroplanes and airships largely by judgment and experience. There is no sure calculation in our handbooks, and the designer risks his reputation and the test pilot risks his life on many new machines. For civil aviation it is especially important for machines sold to the general public to have adequate control surfaces. This is quite as important as to require adequate factors of safety and apparently not one-tenth so difficult. However, the areas and proportions of control surfaces are the only things not covered by specifications. We depend on the test pilot to state whether he finds the control certain and easy.

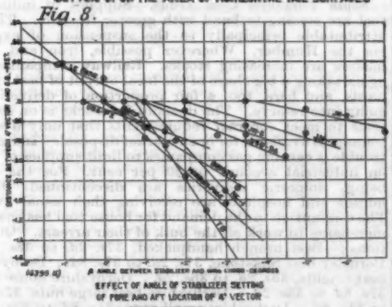
When an important feature of design is so largely a matter of judgment and feeling we look to naval architecture for an analogous problem. The rudders of vessels are made large or small, depending on the manœuvrability desired. The actual design of such rudders is a matter of judgment and experience. For a merchant ship a rudder area from 1/75th to 1/100th the area of the longitudinal section of the ship is found to be quite

Fig. 6.



METACENTRIC HEIGHT
DEPENDENCE OF THE EFFECT OF CHANGE IN ANGLE OF STABILIZER SETTING UPON THE AREA OF HORIZONTAL TAIL SURFACES

Fig. 8.



EFFECT OF ANGLE OF STABILIZER SETTING OF FORE AND AFT LOCATION OF 4° VECTOR

satisfactory for ordinary steering. For warships the turning circle is a military feature, and to give quick manœuvring a rudder relatively twice as large is used. The exact size and shape of rudder to use for any design are determined from an analysis of the rudder proportions of ships of similar type whose turning circles and general behaviour are known. Such mathematical theory of the turning of ships as exists is used in selecting the important variables in the problem, but the analysis results in empirical coefficients.

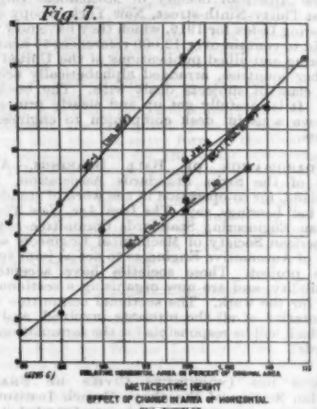
The naval architect's method has been applied to obtain empirical coefficients for the control surfaces of aircraft of various types. It is interesting to note that the average coefficients for very different types are practically the same. The coefficients for the individual machines vary more widely and reflect the individuality of the designers. In particular, the average for 15 German aeroplanes shows an aileron area only 8 per cent. of the wing area, while, in general, the averages lie between 11 per cent. and 13 per cent. It must be that the Germans did not desire a powerful lateral control.

Similar coefficients for the control surfaces of airships show less uniformity and it would appear that airship designers had not yet settled upon simple rules. However, experience with airships is still relatively limited when we consider the immense numbers of aeroplanes that have been built.

Turning how to the proportioning of the control surfaces; both experience and wind-tunnel experiment teach that the best control surfaces are narrow trailing portions of fixed surfaces. This makes for simplicity both structurally and aerodynamically. But a difficulty arises in large machines where it is necessary to balance the surfaces to relieve the load on the pilot. I know of nothing more embarrassing than to have a balanced aileron or elevator flutter violently in flight, unless it be to have the balancing portion twist off entirely.

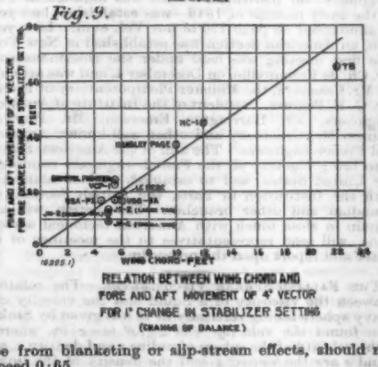
The aeronautical engineer needs some simple rule for the design of balanced control surfaces. It is not practicable to make elaborate wind-tunnel experiments for every design and it is not safe to depend too much on judgment. In order to use simple rules, aeroplane designers must adopt forms which lend themselves to simple computations. Many of the forms of balancing in common use are, aerodynamically, entirely indeterminate. No man can calculate with confidence the force of the air spilling off a wing tip and striking an overhanging portion of aileron. There is certainly a vortex there of a most uncertain nature. Similarly, in the so-called "dovetail" method of balancing where the balancing portion of the control surface works in a recess in the fixed fin, there is a mutual reaction between the two surfaces which is highly indeterminate. The Zeppelin rudders have until recently had this form of balance, but I have noted with satisfaction that the "Bodensee" has changed to a partially overhung type of rudder. The naval architect has long ago been through similar troubles with ships' rudders in rear of the dead wood aft, and concluded that he would use a plain trailing rudder hinged to the stern post with an underhung balancing portion projecting into clean water. The dead wood is cut away forward of this balancing portion. Spade rudders are used where they cannot influence the dead wood or be blanketed by it. If aeronautical engineers would agree to use simple overhung balanced control surfaces, a simple calculation would serve for their design. A calculation for such control surfaces on a number of machines where the centre of pressure of the trailing portion is taken at 0·3 chord length and for overhung portion at 0·2 chord length, has been made and the ratio of balancing to righting moments gives a coefficient which, for the normal case,

Fig. 7.



METACENTRIC HEIGHT
EFFECT OF CHANGE IN AREA OF HORIZONTAL TAIL SURFACE

Fig. 9.



RELATION BETWEEN WING CHORD AND FORE AND AFT MOVEMENT OF 4° VECTOR FOR 1° CHANGE IN STABILIZER SETTING (CHANGE OF BALANCE)

free from blanketing or slip-stream effects, should not exceed 0·65.

To sum up, control surfaces of the usual type can be designed by use of coefficients taken from similar type machines of normal behaviour with every assurance that the manœuvrability of the new design will prove normal.

Abstract of Appendix IV.

Normand's Weight Equation (Rigid Airships).—There is nothing more profitless than an argument over a proposed design between the operating *personnel*, who are always demanding enhanced military characteristics, and the constructors, who are prone to object to change on the grounds that their pet design will be spoiled. Most likely both sides advance very strong arguments to support a particular view of the matter. But such a discussion should not rest on a basis of argument alone, else it degenerates into something resembling that ancient impasse: "Are the mountains better than the seashore." As a matter of fact, the effect of any proposed change in military characteristics can be calculated in a sufficiently approximate manner to make possible a decision based upon evidence. For rigid airships which closely resemble vessels, I propose the use of a naval architect's method for analysing such problems due originally to that eminent French designer of torpedo craft, M. Normand, and subsequently extended and perfected by Professor Hovgaard. By Normand's method, a rapid estimate can be made of the cost in displacement involved by almost any proposed change in the ship.

In the fourth appendix to this paper, I have developed Normand's method to apply to airships by forming the so-called weight equation as the sum of the principal weight groups each expressed in terms of the independent and dependent variables of the design. This weight equation is then differentiated to exhibit the effect of a change in any of these variables and formulæ deduced, analogous to those which apply to vessels, by which a quantitative estimate can be made for the effect of such change.

An airship can be changed in two ways, by preserving similitude of form and permitting the volume to vary or by holding constant volume and changing the ratio of length to diameter. Considering the first case, the factor of proportionality N computed in the fourth appendix is about 4·5 for a ship of L.49 type. This means that an addition of 1,000 lb. to the weight of any item in the ship calls for such increase in other items, to keep the performance the same, that the total lift must be increased 4,500 lb. For battleships N is of the order of only 2·5, indicating a much more favourable situation. The principal reason airships appear to be at a disadvantage comes from the longitudinal members of the hull structure whose weight increases as the fourth power of the length of the ship. Consider now the effect of holding volume constant and changing the fineness of the ship. The longitudinal members of the hull vary in weight as the third power of the length and the first power of the diameter, while the weight of the transverse frame varies as the fourth power of the diameter. If the ship be fattened up, weight is saved on the longitudinals and lost on the transverses. But if the ship be too long originally there will result an important net saving in weight.

Finally, I have applied the method to a rigid airship of the Zeppelin type (L.49) in an example to show how practical answers may be obtained. The displacement of L.49 is assumed to be 1,940,000 cub. ft., or 129,800 lb. If it be proposed to make a new design which shall be similar to L.49, except to have 2,000 lb. more bombs, a 25 per cent. heavier outer cover, and 15 per cent. more speed, the new ship must be given 13,890 lb. more displacement, or a total volume of 2,145,000 cub. ft. The net price paid in displacement is, therefore, about 6 tons.

On the other hand, if the ratio of length to diameter be reduced from 8 to 7, the ship can be built lighter, and the calculations show that a saving in the new design of nearly 5 tons is due to this change of form alone. As a final result, a new ship resembling L.49 might be built having the proposed changes incorporated, and only be slightly larger than L.49; i.e., 1,990,000 cub. ft. The principal dimensions compare as follows:—

Length, L.49, 634 ft.; new ship, 584 ft.
Diameter, L.49, 78·7 ft.; new ship, 83·5 ft.

It would appear that a decrease in the length-diameter ratio is of great advantage, and were it not for the necessity to consider the height of existing hangar doors, airships might well be made fatter than the German models.

Abstract of Appendix V.

The Model Basin.—Naval architects first came into aeronautics in connection with seaplanes. The aeroplane was developed before the seaplane, and at first the great problem was to design the boat or float so that the seaplane could actually leave the water. The early attempts were rarely successful, and it was not until a satisfactory form of planing bottom had been developed by model experiments in the towing basin that any consistent success was had. The contribution of the model basin to aeronautics is too well known to be gone into here. Existing methods and apparatus which had been developed for the study of the resistance of ships were immediately available as soon as it could be demonstrated that Froude's law of corresponding speeds applied to the planing action of flying boats. Such a verification was soon demonstrated by the successful performance of seaplanes designed from the results of model tank experiments.

It is now possible to test in the tank, at small expense and no risk, any proposed form of planing hull and to determine whether or not such a hull is worth constructing full scale. It is, therefore, possible to eliminate a great many types which would prove to be disappointments, and it is also possible to experiment with a great variety of minor modifications in form to determine the effect upon general behaviour of these modifications. As a result of the last four years' work at the experimental model basin at the Washington Navy Yard by my colleagues, Commander Richardson and Commander McEntee, two forms have been developed which, for general purposes, we have found superior to the others. One is a pontoon which has been used on single and twin float seaplanes, and the other is a form of hull which was used for the N.C. flying boats. These forms may not be the best known, as regards resistance or any other single feature, but have proved of all-round utility.

These forms are both what is called "vee bottom," and although this form of bottom behaves well in rough water and reduces the shock of landing, it is objectionable on account of the spray thrown out from the chine. For a twin float installation this is often a serious matter, as the spray gets in the propeller and causes trouble. A recent scheme to protect the propeller from spray has been suggested by Mr. Grover C. Loening. For twin float machines, he proposes floats with a bottom sloping outboard from the inner chine. This appears to eliminate all spray between the pontoons throwing it outboard. The experiments in the towing tank record all those things which can be measured, but do not record the spray and wave formation. We have recently undertaken the study of the wave formation which accompanies a planing boat by the use of an ultra-rapid motion picture camera, which takes pictures at eight times the rate of the commercial machine. When projected on a screen at ordinary speed (16 per second), this gives a view of the whole wave system to a microscopic time

scale. This work is too new to warrant any conclusions from it, but I mention it as being a suggestive means of studying a very complex state of affairs.

An extension of the usual work of the model basin has led to the investigation of the strength of flying boat hulls to resist the shock of landing. For this purpose, accelerometers are mounted in the hull. Attempts to use the R.A.F. accelerometer were disappointing. This instrument had been used in the air for acrobatic flying with very satisfactory results, but it appears that the force at landing is too suddenly applied to be easily measured by this type of apparatus. Another type of accelerometer, developed by Dr. A. F. Zahm, has been used with very consistent results. This instrument depends only on the deflection of a series of light vertical springs by a series of masses and gives a definite maximum. With this instrument landings have been made in smooth water and it appears that the vertical component is seven times gravity and the horizontal component 2·5 times gravity. An R.A.F. instrument mounted alongside the Zahm instrument gave at the same time three times gravity and 1·7 times gravity, respectively. The large vertical components are noteworthy and appear consistent with our experience where engine foundations on flying boats and pontoon struts have failed, although they were designed for a load factor of eight.

Conclusion.—In this paper I have discussed in rapid succession five applications of naval architecture which could only be developed in detail in the appendices. Consequently, I cannot expect to have demonstrated more than the existence of these methods of attack and to have advertised their utility. It will be noted that two principal methods only have been used.

The first is the analysis of experience by means of a comparison of percentage weights, percentage control areas, &c., for a large number of successful aircraft. Similarly an analysis of experience is attempted in the comparison of metacentric heights. Normand's method of differentiating a weight equation is also based upon experience, and the method will not attain its maximum value until weight statements for a great many more airships are available. I cannot urge too strongly the general advantage to the art which would result from the full and frank publication of technical information regarding not only successful designs but failures as well. The failures in particular are priceless, but perhaps it is too much to expect of human nature that a *post mortem* on a bad design will see the light of day.

The second peculiarly naval architectural method used in aeronautics is model experimentation. A theory of similitude, geometrical, mechanical or dynamical, is used to apply model basin tests of boat hulls, wind tunnel experiments on aerofoils, and model propeller tests. Such a general use of similitude in design is unique in engineering practice and forms the closest bond between the naval architect and the aeronautical engineer.

The analysis of experience is really a statistical method for which trustworthy data in quantity are necessary. Given the necessary information, the naval architects' methods not only reveal the past and present state of the art as represented by engineering coefficients and averages but also show the trend of the more successful designs. In that way, future development and the most promising directions for improvement can be predicted. To avoid leaving the impression that the naval architect is looking backward exclusively, I should like to take the opportunity to recall the astonishing success of the little airship built by Dupuy de Lome in 1872. This eminent naval architect attained by his professional skill the maximum success which the state of the mechanical art at that time permitted. His little hand-propelled "Aerial Ship" exhibited all of the principal features of our modern non-rigids in their fundamental forms. Control and stability were correctly understood and provided for. An air-speed meter was also provided. The requirements of our modern theory of suspending a car below a non-rigid gas bag were met by his suspension system. A ballonnet and blower were used in accordance with good practice. More remarkable still, Dupuy de Lome made the envelope of two-ply rubberised fabric and doped it with a very fair gelatine, glycerin, acetic acid varnish to make it tight.

I quote from a contemporary account :—*

"The stability was something marvellous; several persons moving about in the car at the same time did not produce any oscillation. A descent was intentionally made from 1020 m. to 600 m. without making use of the ballonnet. The folds in the balloon then became very marked, and it was interesting to observe the tension of the various ropes as they maintained the major axis of the balloon in a horizontal position.

"The complete agreement of the results of the trial with those foretold by the inventor will be obvious to everyone. Such an agreement, usually so rare, is the more extraordinary as in this case all the bases of calculation had to be discovered.

"Henceforth aerial navigation may be said to possess a theory of stability and propulsion. The true history of ballooning will date from February 2, 1872, a new era marked by the invention of the navigable balloon, and rendered illustrious by the name of M. Dupuy de Lome, so well known in connection with scientific progress and invention."

The name of Dupuy de Lome deserves to be remembered not only as the leading naval architect of his day, but also as the first naval architect to apply his art to aeronautics.

In closing, I should like to express my appreciation of this opportunity to present before this society some of the later knowledge of the Navy Department in an effort to make at least a small return for the very valuable work which the Royal Aeronautical Society has done in publishing and distributing for the benefit of the art the best knowledge of British aeronautical engineers. My chief, Admiral D. W. Taylor, Chief Constructor of the Navy, especially welcomed this continuation and extension of the cordial relations established during the war, and authorised me to disclose anything or everything of value in the possession of the Bureau of Construction and Repair. The Secretary of the Navy is much pleased that an officer of the United States Navy has been invited this year to read the Wilbur Wright Lecture, and desires me to express his gratification. The foundation of the Wilbur Wright Lecture is an institution very much to the credit of the Royal Aeronautical Society, which is not only the oldest aeronautical body in the world, but also the first to found a permanent memorial to my countryman. This early recognition of the Wrights by this society has ample justification, for this very Hall might not still exist to-night had not Wilbur and Orville Wright's invention been overhead to protect it. In honouring Wilbur Wright, we meet on a common ground. Firstly, relations between our countries will be furthered by transatlantic flying, and it seems very appropriate that the most intimate contact should be maintained by those technical and scientific workers who are striving for the same end: The improvement and application of the gift of flight left us by Wilbur Wright.

* Leclert, "Naval Science," April–October, 1872.

"THE ENGINEERING INDEX, 1919."—We have received from the American Society of Mechanical Engineers, 29, West Thirty-Ninth-street, New York, a copy of their Engineering Index for 1919, which they have now issued. It is said to contain over 12,000 references to nearly 700 engineering and allied publications of the United States and other countries, arranged alphabetically according to the class of subjects dealt with. The book costs 4 dols. It is carefully got up and clearly printed, and will prove a useful desk companion to engineers and scientists.

STANDARDISATION OF BALL BEARINGS.—At the request of the Swiss Standards Association, Baden, Switzerland, for co-operation in the work of standardisation of ball bearings, says *The Iron Age*, New York, the American Engineering Standards Committee requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors for the project. These societies have accepted the responsibility, and are now organising a sectional committee for the work. The sectional committee will be representative of all the interests involved, and is the body which will be responsible for the formulation of the standards.

SOCIETE DES INGENIEURS CIVILS DE FRANCE.—A London Section of the above French Institution of Engineers—an Institution which was founded in Paris in the early months of 1848—was established last year, as announced on page 726 of our Vol. cviii. Last year, also, an American Section was established in New York. The first meeting was held under the chairmanship of Mr. Ch. de Fréminville, on December 4, and was attended by Mr. Casenave, the Minister Plenipotentiary of France, Mr. G. E. Pegram, President of the Institute of American Engineers, Mr. Harrington Emerson, Mr. Heyward Gaines, Mr. Granberry and other well-known American and French engineers. The aim of the American Section is to bring together all the French engineers residing in the United States, and to establish a close connection with the Institution in Paris, the British Section, the Canadian and other branches. The section will also remain in close touch with American technical associations, will send representatives to the meetings of the latter and report upon the proceedings.

THE FALLING-SPHERE VISCOSIMETER.—The relations between the viscosity of a liquid and the velocity of a heavy sphere falling vertically in it was given by Stokes, who found the velocity $v = 2\,g\,r^2\,(s-\sigma)\,9\eta$, where v is the velocity of the sphere of radius r and density s, and η and σ are the viscosity and the density of the liquid. Ladenburg applied the method in 1907 for determining the viscosity of Venice turpentine under pressure and investigated experimentally and mathematically the limits of the applicability of the method, which had previously been studied by Rayleigh and by Allen, with respect to the determination of the absolute viscosity. These studies were taken up in 1917 at the Woolwich Arsenal in connection with the manufacture of propellant explosives with regard to the viscosity of solutions of nitrocellulose. It was found by W. Howilson Gibson and his collaborators (Journal of the Chemical Society, May last, pages 573 to 593), that certain treatments will affect the physical properties and viscosity of cellulose profoundly, whilst hardly changing the chemical properties. The apparatus serving for the viscosity determinations is a glass test tube, 2 cm. in diameter, nearly 30 cm. long, placed vertically in a cylinder filled with water at 20 deg. C. The test length in the tube is 15 cm. It was observed that as the diameter of the tube increased from 0.85 cm. to 4.5 cm., the time of fall of the sphere, through castor oil, decreased from 25 seconds to 17.4 seconds; a diameter of 2 cm. was hence adopted. The spheres are steel balls for bearings, 0.15 cm. in diameter, readily obtainable in exact dimensions. The experiments prove that the method is reliable for liquids of viscosities similar to or greater than that of castor oil, subject to the corrections proposed by Ladenburg, Rayleigh and Allen. In a similar investigation, published in 1917 in the Journal of Industrial and Engineering Chemistry (pages 523–529), S. E. Sheppard had arrived at a somewhat different correction formula, and had advocated the use of large steel balls; Gibson does not see any advantage in Sheppard's suggestions.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Large arrears of orders enable the heavy engineering trades to maintain an appearance of normal activity. As regards new business, however, conditions are quieter, and the prospect less hopeful. Apart from the indisposition of Continental consumers to accept heavy liabilities with currency at a diminished value, a general spirit of caution prevails among both buyers and sellers in all departments. The feeling appears to be gaining ground that prices are fast approaching the highest maxima, and that to have on hand stocks that cost more than four times the pre-war price would be to run the risk of heavy loss should a fall suddenly occur. Orders for the most part are therefore restricted in the case of raw and semi-finished materials to essential requirements for daily use. The scarcity of certain kinds of products, however, is causing a good deal of dislocation, and is compelling the payment of heavy premiums on revised quotations. The heavy steel foundries are finding the greatest difficulty to keep pace with commitments, owing to the scarcity of foundry pig-iron. Deliveries of castings are not going out as users would wish, and engineering construction is suffering something of a set back on this account. While it has been found possible to supplement deliveries of castings from foreign sources, the irregularity and uncertainty of supplies have diminished the value of this service. There is also a big deficiency in local output of bright rolled strip. Sheets and plates are almost unprocurable, except on contract account. The export demand for railway axles, springs and tyres has lately improved, but otherwise the volume of business arriving at local works is barely sufficient to find full-time employment on the considerably extended plants. Colonial buyers are again paying rather more attention to crucible steel. Makers of high-speed and other special steels report a fairly healthy tone, their chief difficulty being the scarcity of those alloys the production of which is chiefly in American hands. Makers of hand tools are reported to be booked up for the next six months. The scarcity of certain classes of raw material is causing steel makers to pay special attention to the scrap market. Consequently prices have stiffened. Heavy steel scrap stands at about 12*l.* per ton, heavy wrought-iron scrap at the same figure, heavy cast-iron scrap at 11*l.* 10*s.*, and light cast-iron scrap 9*l.* 12*s.* 6*d.* Derbyshire makers of pig-iron have advanced their quotations 7*s.* 6*d.* per ton. Grey forge is now quoted at 12*l.* 15*s.*, and No. 3 foundry at 13*l.* 2*s.* 6*d.*

South Yorkshire Coal Trade.—Supplies of industrial fuel are coming to hand with greater freedom. This is attributable principally to the suspension of exports *via* the Humber. Wherever possible, iron and steel makers are increasing stocks. Railway companies are again taking a big share of the local output of best steam hards, and here, too, a fair proportion of deliveries is going into reserve. The demand for slacks is on such a scale to meet contract requirements that only a small tonnage is available for open market disposal. Industrial trouble is causing gas companies to limit supplies of coke on industrial account to 50 per cent. For the time being, domestic deliveries are discontinued. Bakehouses and hospitals are receiving their usual quota. The diminution in the demand for house coal has enabled merchants to work off the bulk of their arrears. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Scarcity of Cleveland pig-iron continues very pronounced. Producers still refuse to sell for abroad, and they have little to offer on home account, most of the output being absorbed by consuming works who either own or control the blast furnaces. Export prices are not named, and what iron comes on the market is promptly taken up for home purposes at 217*s.* 6*d.* for No. 3 and the inferior grades and 230*s.* for No. 1.

Hematite Iron.—Supply of hematite iron is little better than is that of Cleveland pig-iron, but in addition to the limited home trade passing, occasional odd lots can be bought for despatch to foreign ports. Makers are well booked and are not keen to make further sales. There are still tempting offers from abroad, but, placing the needs of the home traders first, producers have little surplus for Continental trade, and foreign orders have been turned down. For home consumption, Nos. 1, 2 and 3 East Coast brands are 260*s.* and No. 1 is 262*s.* 6*d.*; and for shipment to France, Belgium and Italy, mixed Nos. are 265*s.* and No. 1 is 267*s.* 6*d.*

Manufactured Iron and Steel.—Producers of manufactured iron and steel have a vast amount of work on hand, but disturbing influences are beginning to assert themselves. Foremost among these are reported cancellation of shipbuilding orders, growing American and Belgian competition, and refusal of Continental customers to pay the prices now ruling. A pronounced feeling prevails that prices have touched top. The principal market quotations include:—Common iron bars, 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; rivets, 38*l.*; steel ship, bridge and tank plates, 23*l.* 10*s.*;

steel angles, 23*l.*; steel joists, 23*l.*; soft steel billets, 25*l.* 10*s.*; hard steel billets, 26*l.* 10*s.*; heavy steel rails, 23*l.*; fishplates, 28*l.*; black sheets, 44*l.*; and corrugated galvanised sheets, 54*l.*

Output of Pig-Iron.—With production of pig-iron very inadequate to needs, it is gratifying to learn of efforts being made to put idle blast furnaces into operation. The new furnace, recently constructed at the Redcar Ironworks of Messrs. Dorman, Long and Co., Limited, will be started as early as possible. It is equipped with Cowper stoves, and high-power turbine blower, and is expected to turn out about 1,200 tons of pig-iron per week, which is a much greater production than that of other furnaces in this district. An old furnace at the Redcar works has been demolished, and is to be replaced by another of similar type to the one recently built.

Foreign Ore.—Transactions in foreign ore are few and small. Consumers continue to hold off the market as they have still substantial stocks, and good contracts made. They report that they would have no difficulty in placing orders over the third quarter of the year on the basis of 49*s.* for rubio, of 50 per cent. quality, on the 17*s.* parity freight, Bilbao-Middlesbrough. This makes the c.i.f. Tees value of best rubio 59*s.*, as steamers from the Spanish ore port are being fixed at 27*s.* Some sellers however, declare that they would not make contracts on such terms, and profess to see signs of the position hardening.

Coke.—Coke is in heavy request, and the home market is quite active, but foreign business is difficult to arrange. Average blast-furnace kind is 62*s.* 9*d.* at the ovens; low phosphorus sort, 65*s.* 3*d.* at the ovens; and foundry description, 70*s.* 3*d.* for home purposes. For export gas-house product is 170*s.*, and foundry coke is 160*s.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

State of Trade.—Very little change falls to be noted in the general conditions of trade in Scotland, although one or two industries are not quite so pressed for deliveries. This latter statement does not apply to the iron and steel trades, however, as these are abundantly supplied with orders and buyers are continually seeking delivery of material. The annual Fair Holidays in Glasgow district commence in three weeks' time, and the pressure for deliveries before the stoppage will be greater than ever, and already there are signs of this. Supplies of raw material are not up to the standard required by trade in general, and the prospect of some dislocation in shipping through the dispute with the wireless operators may have far-reaching effects on supplies of one kind and another. Prices all round are strong and show no signs of easing off.

Scotch Steel Trade.—Much pressure for deliveries of all classes of steel material still continues owing to the abundance of work on hand throughout the country, and no lessening of activities is reported from the steel works. The production is large, but is still not nearly sufficient for the requirements of consumers because of the shortage of raw materials. Supplies of hematite iron are scarce, and operations at the works are being somewhat hampered in consequence. Shipbuilders are absorbing a very large quantity of steel plates and deliveries are often anxiously awaited at the yards in order to save broken time. Boiler plates are likewise in great request, and constructional firms are getting through a large tonnage of sectional material. The makers of black sheets report no change in conditions, and all are being kept very busily employed with orders booked some considerable time ago. Home consumers are absorbing the bulk of the present output and exporting is still on the small side, not only in the case of sheets but with all steel material in general, and quite a large trade could be done were the stuff available. Prices show no alteration over the week and a firm tone prevails.

Malleable Iron Trade.—The malleable iron makers in the West of Scotland have very heavy order books, and deliveries are a good way behind despite all efforts to work off arrears. Fresh bookings have not been quite so heavy recently, but that causes little concern meantime, as everything for months to come is already sold. Quotations remain firm, and even with these on to-day's high level consumers keep pressing for deliveries.

Scotch Pig-Iron Trade.—The pronounced scarcity of pig-iron is not to the liking of consumers, all of whom could take in about double the quantity they are at present receiving, but all efforts to increase outputs seem unavailing. Supplies fall a long way behind the demand of the home users and of course little shipping business is being done, although many foreign clients continue to send forward good inquiries in the hope that whenever there is anything to spare they will have first refusal of it. Both hematite and foundry iron are being spread over as many of the regular customers as possible in fair proportions, but sometimes the deliveries are not too heavy, and new buyers find it very difficult to secure almost anything at all. Foundry iron round 14*l.* 10*s.* per ton seems no deterrent to consumers so great is their need at present, and although that is an exceptionally high price one never knows but what it will yet go higher. The market is certainly very firm and there would seem to be no reason for producers to think of shading quotations yet awhile.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

Miners and Piece Work.—An important decision as affecting coal outputs was come to at the recent annual conferences of the South Wales Miners' Federation. A motion was submitted from several districts in favour of doing away with the present system of payment by results, and eventually a resolution was carried to the effect that three months' notices be tendered to the employers to abolish piece-work in the South Wales coalfield. It was, however, further resolved that before taking this step a ballot of the coalfield be taken in order to ascertain the opinion of the members of the federation. In view of the fact that the piece-workers are comprised mainly of coal hewers and timbermen, and that consequently the majority of the workmen are already on day rates, it is practically certain that the majority of the members of the organisation will vote in favour of the abolition of the piece system and thus do away with the incentive to produce the maximum quantity of coal. It is thus possible, if not indeed probable, that this step on the part of the federation may lead to rather serious trouble in a few months time. For the present there is an improvement in regard to production following the intervention of the holidays, but the 1,000,000 tons weekly mark has not yet been reached, which is partly due to the existence of sectional strikes.

The Coal Market.—There has been no material alteration in the position of the coal market. Export business has been stagnated by the policy of the Government in restriction of cargo and bunker shipments to a definite quantity which allows individual collieries such a limited amount for shipment that exporters find it almost impossible to make up a decent sized cargo. On the other hand colliery salesmen experience difficulty in securing markets for the quantities which they have to send inland, and customers in many cases report their inability to accept further deliveries because of a lack of stocking accommodation. It is officially announced that the present system under which coals are allocated for export is to be substituted by the application of a system of permits under which scheme collieries will be granted permits for the export of the quantities allocated to them in so many lots, and these permits will be handed to shippers for the quantity to be shipped, and submitted with the pre-entry form to the Coal Controller's local representative for the usual endorsement. How this scheme will work remains to be seen, but it is the general opinion that matters cannot be worse than they are at present. In fact, difficulties in connection with the supply of empty wagons are imperilling the regularity of work at collieries and it is believed that stoppages can only be averted by an increase in the quantity of coal available for export.

THE MERCANTILE YEAR BOOK.—"The Mercantile Year Book and Directory of Exporters" for the current year, edited by Walter Lindley-Jones, F.R.G.S., and published at the price of 20*s.* net by Lindley-Jones and Brother, 16, St. Helen's-place, Bishopsgate, E.C. 3, has the well-known features of former editions. It contains a guide to the shippers of London arranged in order of the streets; a list of importers in the Colonies and foreign countries giving the class of goods imported and the names of the European representatives in every case; the names of merchant exporters of London, arranged alphabetically, with the indication of the market in which each firm largely deals; a directory of the classes of goods shipped from London and the names of the shippers. Similar information is given in the case of British provincial cities and a number of Continental towns. The book appeals to a wide circle of the British business community and will greatly facilitate intercourse between selling firms in this country and consumers abroad, and between intending purchasers abroad and London and provincial exporters.

PHOSPHATES IN NAURU ISLAND.—The allied and associated Powers have decided that a mandate for the administration of the Island of Nauru, in the Pacific Ocean, shall be conferred upon the British Empire. On July 2, 1919, an agreement was signed between H.M. Government in London, H.M. Government of the Commonwealth of Australia, and H.M. Government of the Dominion of New Zealand, in relation to that island. The agreement provides for working the phosphate deposits on the island, and is submitted to Parliament as a schedule to the Nauru Island Agreement Bill for confirmation. It is provided in the agreement that any right, title or interest which the Pacific Phosphate Company or any person may have in the phosphate deposits on the island, and in the land, buildings, plant and equipment shall be converted into a claim for compensation at a fair valuation. The amount of such compensation shall be contributed by the Governments of the United Kingdom, the Commonwealth of Australia, and the Dominion of New Zealand in proportions to be mutually agreed upon. The proportions have been fixed as follows: United Kingdom, 42 per cent.; Australia, 42 per cent.; New Zealand, 16 per cent. An agreement has been arrived at with the Pacific Phosphate Company for the voluntary cession of their rights in respect of these phosphates, and also of the rights which they have, under licence from H.M. Government, to the phosphates on Ocean Island. The amount of the compensation so payable has been agreed at 3,500,000*l.*, together with a further sum not exceeding 39,000*l.* in respect of compensation to certain officials of the company if their services are not retained by the Commissioners. The share of the United Kingdom in this amount is consequently 1,486,380*l.*, which Parliament is to be asked to provide. The sum to be asked for also includes provision amounting to 1,620*l.* for legal expenses, making a total of 1,488,000*l.* This sum will be repayable with interest out of the proceeds of the sale of phosphates by the Board of Commissioners to be set up and representing all three Governments who are parties to the agreement.

NOTICE OF MEETING.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Wednesday, June 30, at 6 p.m., at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, Westminster, S.W., "Electric Railway Contact Systems," by Sir Philip Dawson, Member.

AUTOMOBILE CLUB DE FRANCE.—We have received from this club, whose address, as is well known, is 8, Place de la Concorde, Paris, a booklet containing the rules and regulations for its sixteenth Grand Prix, to take place in 1921. The date and place are to be announced later.

BRITISH SCIENCE GUILD.—The issue, No. 11, for June of the journal issued by the British Science Guild, gives an agenda of the annual meeting, information on the activities of the Guild, papers on the latter's objective, &c. It can be obtained at the price of 1*s.* 1½*d.* post free, on application to the Secretary, 6, John-street, Adelphi, W.C. 2.

"DAILY MAIL" EFFICIENCY EXHIBITION.—We have received from *The Daily Mail* an illustrated booklet dealing with the Efficiency Exhibition which that journal is organising. It is to be held at Olympia from February 10 to 26 next. It contains a table showing that for nine industries the output in 1907 for the United Kingdom was an average per wage earner of 181*l.* 0*s.* 2½*d.*, the horse-power employed being 0·46866, also per wage earner. The corresponding figures for the United States in 1909 were for the same nine industries 491*l.* 1*s.* 2*d.* and 0·97322 h.p. The booklet gives further particulars on the scope and object of the forthcoming exhibition and data on past exhibitions organised by the same journal.

GERMAN MACHINE MANUFACTURERS AND THE EXPORT TAX.—The British Commercial Commissioner at Cologne reports to the Department of Overseas Trade that a meeting of the German Association of Machine Manufacturers was held in Berlin on the 18th inst., attended by all branches of the industry, when a protest was sent to the Government against the introduction of the new Export Tax Law, and it was moved that the Government be asked to repeal it. With a few exceptions (mainly electrical goods, on which from 1 per cent. to 8 per cent. will be levied), the export tax is 6 per cent. of the export value. Details of the schedule may be obtained from the Department, 35, Old Queen-street, S.W. 1.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—It is the intention of the London Students' Section of the Institution to visit Scotland from Saturday, July 24, until Saturday, July 31. The following is an abstract from the programme which has been arranged: Social meeting in the Corn Exchange Restaurant, Gordon-street, Glasgow; visit Dalmarnock Power Station, Glasgow; visit the Dykehead Colliery (Larkhall) of Messrs. The Summerlee Iron Company; sail by steamer to Rothesay, Bute, thence by electric tramcar to Ettrick Bay; visit the power station and depot of Messrs. The Rothesay Tramways Company; visit Messrs. Mavor and Coulson, Limited, electrical manufacturers, Glasgow; visit the engineering laboratories of the Royal Technical College and the University, Glasgow; sail by turbine steamer to Arran; visit Messrs. G. and J. Weir, Limited, engineers, Cathcart, Glasgow; visit Messrs. John Brown and Co., shipbuilders, Clydebank.

THE ROYAL SOCIETY OF ARTS.—The Council of the Royal Society of Arts have awarded medals for the following papers read before the society during the session 1919–20:—At the Ordinary Meetings: Mr. John Westall Pearson, "The Seed Crushing Industry"; Mr. Sidney Preston, C.I.E., "English Canals and Inland Waterways"; Sir James Currie, K.B.E., C.M.G., "Industrial Training"; Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships." In the Indian Section: "Sir William Stevenson Meyer, G.C.I.E., K.C.S.I., "The Indian Currency System and its Developments"; Mr. Albert Howard, C.I.E., M.A., F.L.S., "The Improvement of Crop Production in India"; In the Colonial Section: Sir Francis Watts, K.C.M.G., D.Sc., "Tropical Departments of Agriculture, with Special Reference to the West Indies." At a Joint Meeting of the Indian and Colonial Sections: Sir John Cadman, K.C.M.G., D.Sc., "The Oil Resources of the British Empire."

THE SURVEYORS' INSTITUTION.—The country meeting of the Surveyors' Institution at Gloucester will take place on Thursday and Friday, July 8 and 9. On the morning of the 8th the members attending will be received at the Guildhall by the mayor, and papers on "Gloucester" and "The Agricultural Bill" will be read and discussed. Members and guests will lunch together at the New Inn, and afterwards one party will visit the cathedral whilst another will inspect the Gloucester Wagon Company's works. In the evening the Institution dinner will be held at the Bell Hotel, at which a number of official guests will be present. The second day will be devoted to excursions, one party going by boat to Tewkesbury and returning by the same route stopping at Maismore Park to inspect Mr. J. J. Cridlan's famous herd of Aberdeen Angus cattle. Another party will make a tour by motor char-a-banc through the Cotswolds, stopping on route to visit the Roman Villa and woods at Chadworth, Cirencester Abbey, Roman pavement, &c., and Lord Bathurst's park and woods.

SELF-CONTAINED WATER COOLER.

CONSTRUCTED BY MESSRS. HEENAN AND FROUDE, LIMITED, ENGINEERS, WORCESTER.

Fig. 1.

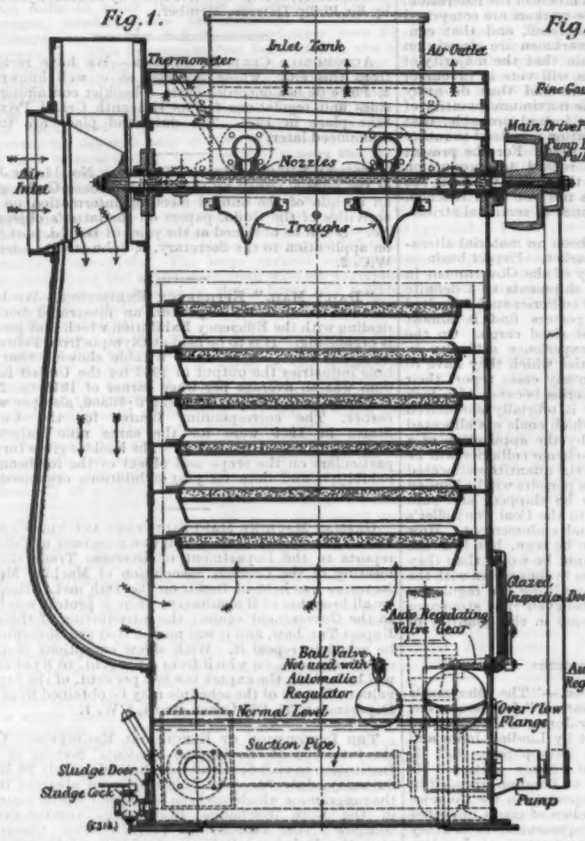
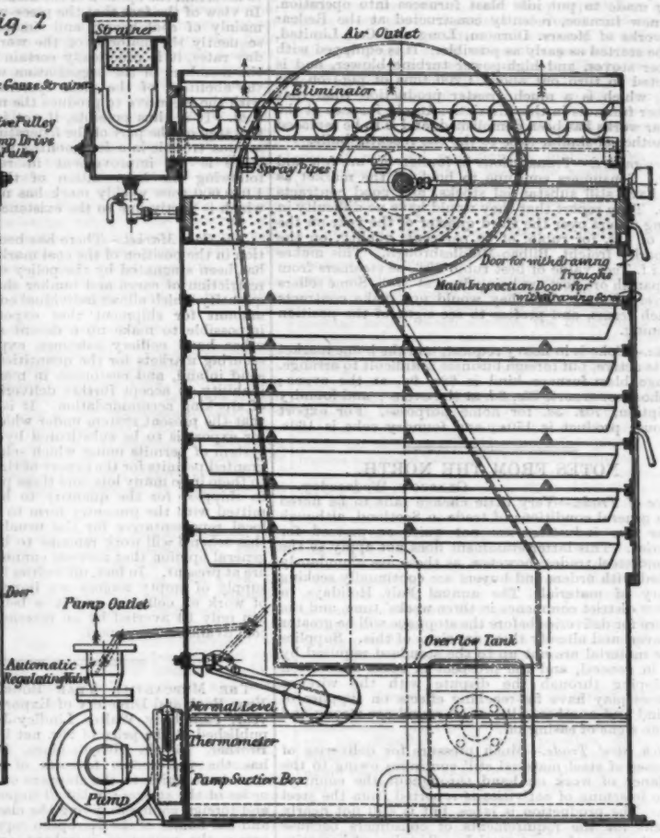


Fig. 2



The cooling of the jacket-water of stationary internal-combustion engines is frequently carried out by means of a cooling tank or reservoir, and in such cases the loss of water by evaporation varies from 0·2 gallon to 0·4 gallon per brake horse-power hour. Some 30 gallons to 35 gallons of cooling-tank capacity is required per brake horse-power. With large gas engines cooling towers are common. These have a loss by evaporation somewhat greater than a cooling tank, amounting to 0·4 gallon to 0·5 gallon per brake horse-power hour. In these methods of cooling by air the temperature to which it is possible to cool the water dealt with is, of course, absolutely dependent on air temperature as registered by the wet-bulb thermometer, and the nearer it is desired that the water shall approach the temperature of the air the larger and more expensive the cooling plant becomes. The efficiency of a cooler depends almost entirely on the means adopted to bring the water into intimate contact with the air.

An interesting cooler, which has recently been introduced by Messrs. Heenan and Froude, Limited, of Worcester, claims a minimum consumption of water per brake horse-power hour, and has the advantage of being compact and occupying comparatively small space. The apparatus is also self-contained. It is of the stationary type, and has no moving parts beyond the fan which circulates the air and the pump which circulates the water. The apparatus is illustrated in Figs. 1 and 2 above. It consists of a rectangular casing built up of mild steel plates and stiffened with angles where necessary. The base forms a tank into which the water drains after cooling, ready to be returned to the engine jackets, or to whatever other service the cooler is used in connection with. Cooling is obtained by distributing the water over a number of horizontal screens set up, one above the other, in the body of the cooler. The water enters through a strainer at the top, which can be seen in the figures, and falls on to the screens through nozzles which feed perforated troughs. In its fall through the screens it meets a current of cold air which is forced upward through the casing by a centrifugal fan. The fan is fixed at the top of the machine and the air passes down a trunk at the side, as shown.

The screens are formed of brass or phosphor-bronze metallic wool, of standard size and thickness, held together between brass wire netting which is attached to galvanised angle-steel frames. The screens rest on angle brackets and are easily removed, for inspection or cleaning, through the side door which can be seen in Fig. 2. Experience shows that removal is seldom necessary. Across the upper part of the cooler casing a number of eliminators are fixed. These consist of curved galvanised steel blades and are designed to arrest the diffusion of water in the form of loose particles carried by the current of heated air which emerges from the top of the cooler.

As will be seen from the illustrations, the fan runner is keyed to a shaft which is enclosed in a tubular casing, this casing passing through the upper part of the cooler. The fan is mounted at one end of the shaft, while at the opposite end is fixed a driving pulley. In the figures this pulley is shown with two diameters. The main drive is on the larger of the two and from the smaller diameter a belt drives the centrifugal water-circulating pump which is fixed at the bottom of the machine. In an alternative arrangement an electric motor drives the pump direct, and a pulley mounted on its main spindle drives the fanshaft through a belt. It will be clear that there are no moving parts in the cooler except the fan and pump, and no parts subject to derangement. The fan deals with dry air from the surrounding atmosphere, and is not immersed in saturated air, which might cause corrosion.

In the ordinary standard sizes the machines we have described vary in capacity from 625 gallons per hour to 55,000 gallons of water cooled per hour. A medium-sized cooler working in conjunction with, say, a petrol engine or dynamometer, can deal with 10,000 gallons of water an hour and cool it from 170 deg. to 100 deg. F., extracting 7,000,000 British thermal units per hour. Working with, say, an air compressor and dealing with the same quantity of water, it could cool from 85 deg. to 75 deg. F. and extract 1,000,000 British thermal units per hour. These figures assume temperate climatic conditions.

As the machine is completely enclosed it can be placed in an engine-room without the atmosphere becoming impregnated with moisture, the heated air discharged being, of course, led away. In connection with the use of the apparatus for dealing with the cooling water of air compressors, it will be very evident from our description that it might alternatively serve as an air cooler and filter. Dust and dirt suspended in the air would be washed out in its passage through the machine, and if cold water were used it would also be greatly reduced in temperature. The effect would, of course, depend on the difference between the temperatures of the air and water.

THE LATE MR. HAROLD STAVELY BOUMPHREY.—We regret to have to record the death, which occurred on Friday, the 11th inst., of Mr. Harold Stavely Boumphrey, the assistant superintendent engineer of the White Star, Dominion and American Lines. Mr. Boumphrey started his career as an engineer by serving an apprenticeship of seven years with Messrs. Laird Brothers, Birkenhead; he then was with Messrs. John Glynn and Sons, and in November, 1900, he joined the White Star Line as a junior engineer. From that date he served in various steamers, he rose to the position of chief engineer and was appointed assistant superintendent engineer of the Line in November, 1906. Mr. Boumphrey was a man of genial, upright and absolutely fearless character, and enjoyed great popularity. He was a member of the Liverpool Engineering Society and of the Marine Engineering and Naval Architects Guild.

THE "CARMANIA."—An interesting illustrated booklet has been issued by the Cunard Company, describing the fight off Trinidad, on September 14, 1914, when the Carmania sank by gun-fire the German ship Cap Trafalgar, of the Hamburg-South America Line. The latter ship left Buenos Ayres on the same day as the Carmania left Liverpool, and the German ship had her guns on board. The booklet illustrates and describes the damage caused to the Carmania by gun-fire. It is interesting to note, with reference to the transformation of the British ship for war service, that she arrived at Liverpool landing stage on August 7, 1914; she was taken in hand at once, and fitted out as an armed merchant cruiser in the short space of one week. She carried eight 4·7-in. guns. In alluding to the fight, Admiral the Hon. E. R. Fremantle, C.C.B., C.M.G., said there never was a single-ship action which reflected greater credit on the Royal Navy, the Mercantile Marine, and more especially the Royal Naval Reserve, than the one in question.

THE WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

(*For Description, see Page* 847.)

FIG. 2. IRON FOUNDRY.

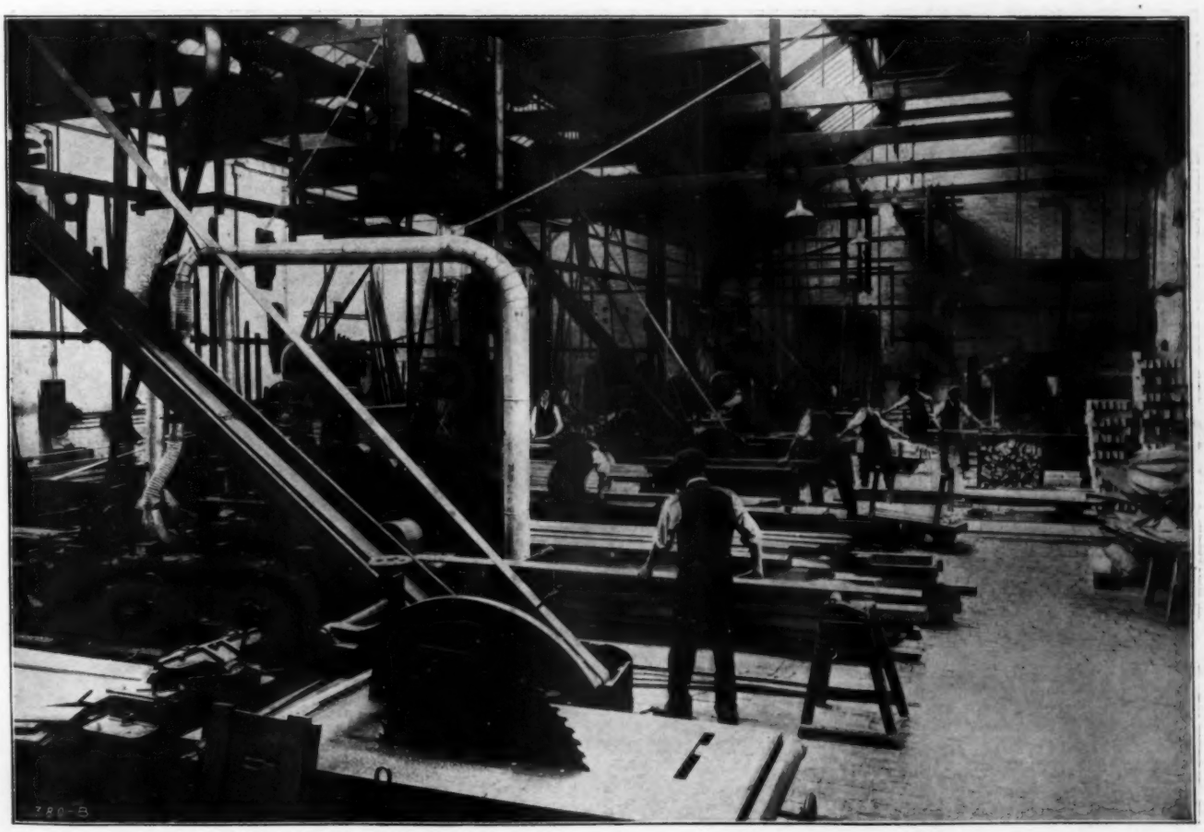


FIG. 3. SAW MILL.

(*To face page* 848.)

THE WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

(*For Description, see Page* 847.)

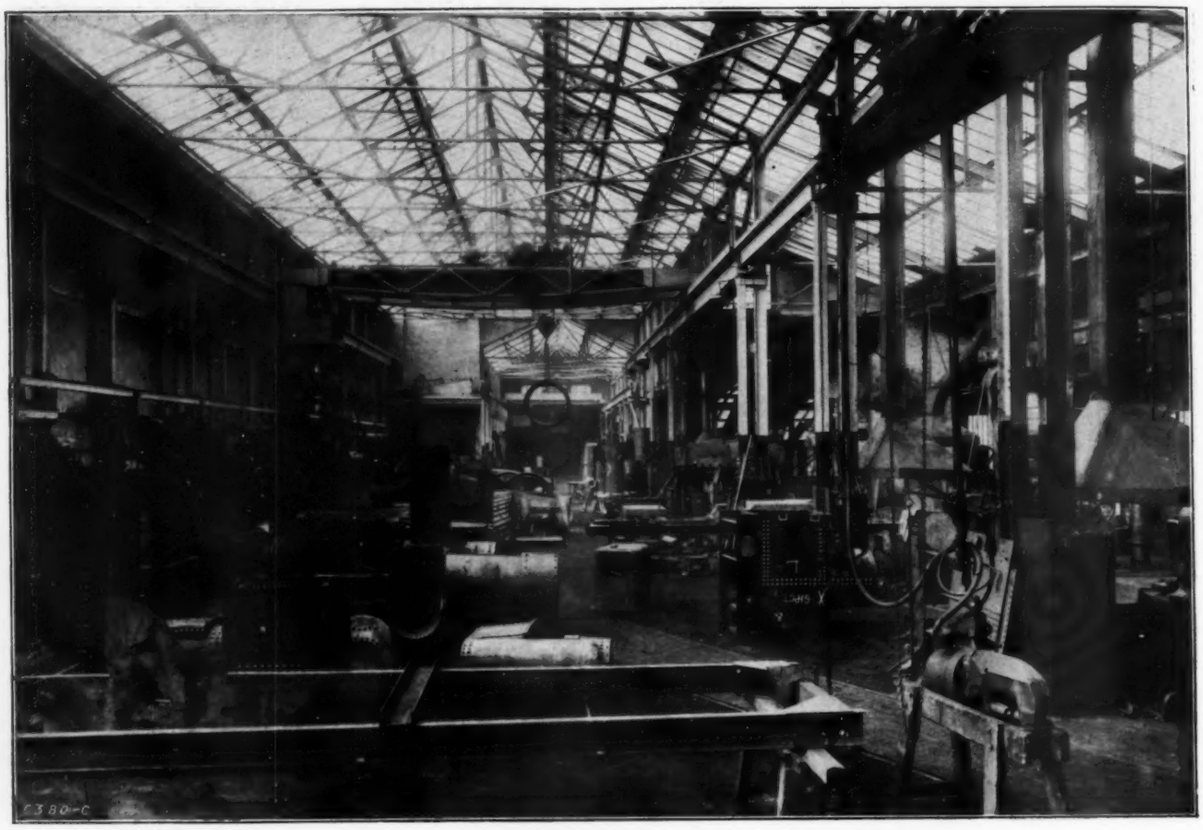


FIG. 4 BAY IN BOILER SHOP.

FIG. 5. CENTRE BAY OF TURNERY.

THE WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

(*For Description, see Page* 847.)

FIG. 6. DRILLING SHOP

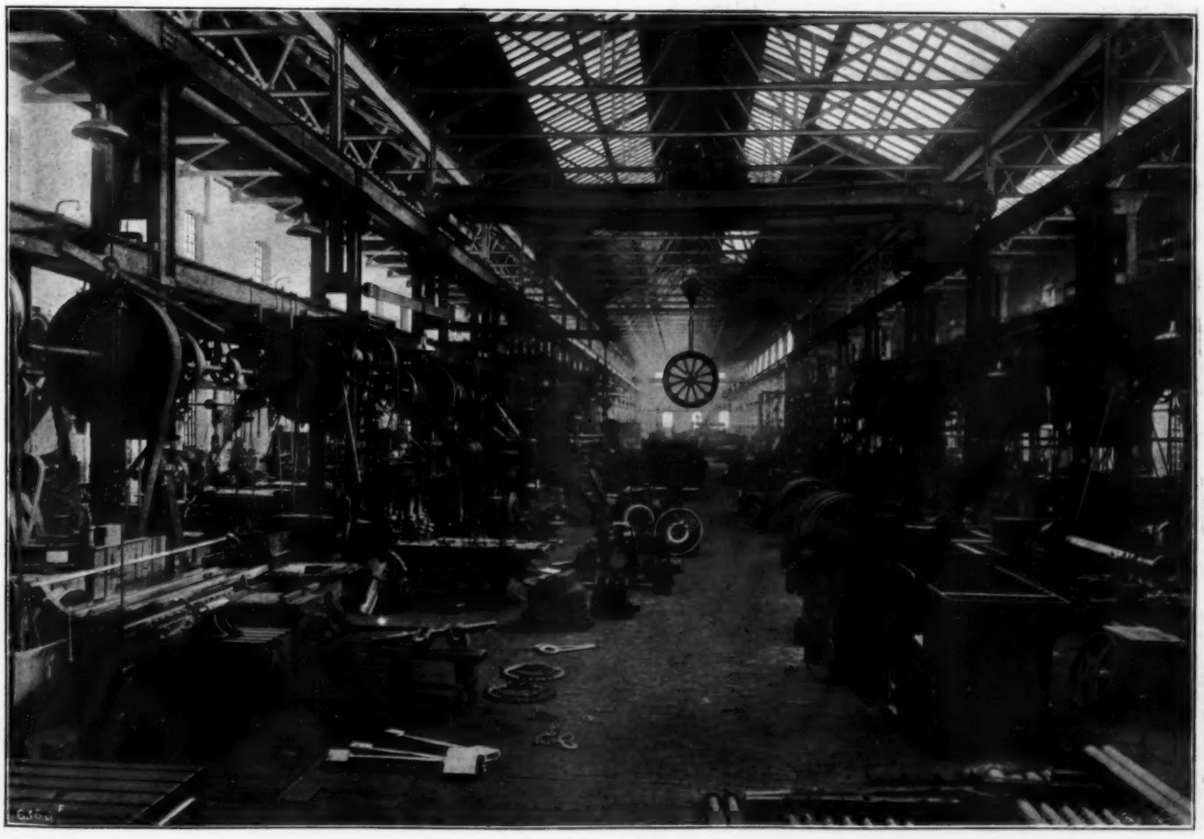


FIG. 7. MACHINE SHOP.

THE WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

(*For Description, see Page* 847.)

FIG. 8. NORTH BAY OF ERECTING SHOP.

FIG. 9. ERECTION OF TANKS IN WAR TIME.

(*To face page*, 849.)

200-TON STEAM FLOATING CRANE AT THE BIRKENHEAD SHIPY

(For Description, see Page

Fig. 1.

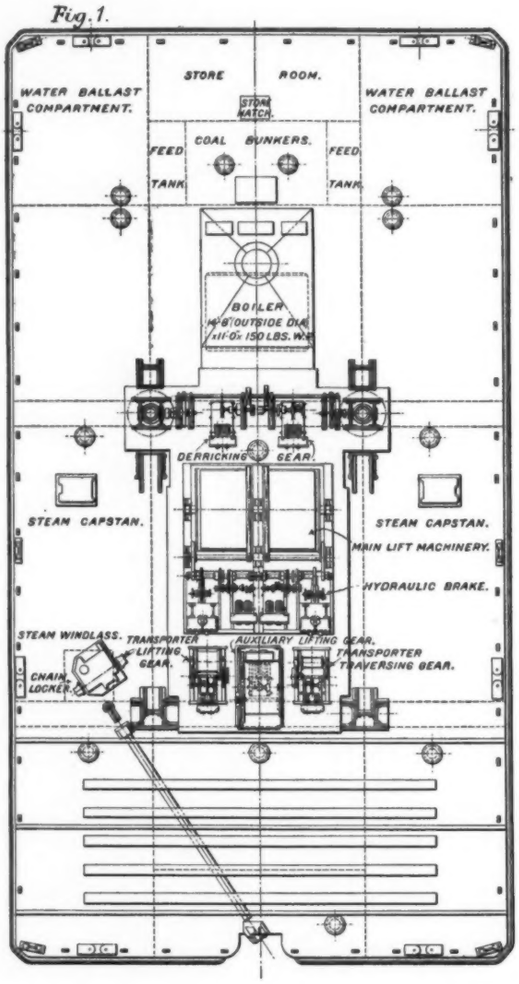


Fig. 4.

DIAGRAM SHOWING CRANE WITH AN OVERHANG OF 65'-0" UNDER A LOAD OF 200 TONS.

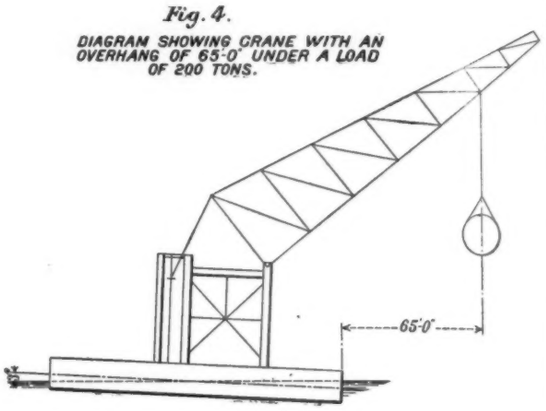


Fig. 5.

DIAGRAM SHOWING CRANE AT MINIMUM RADIUS WITHOUT LOAD.

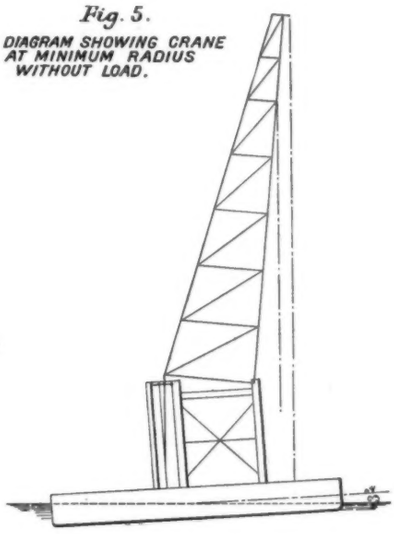
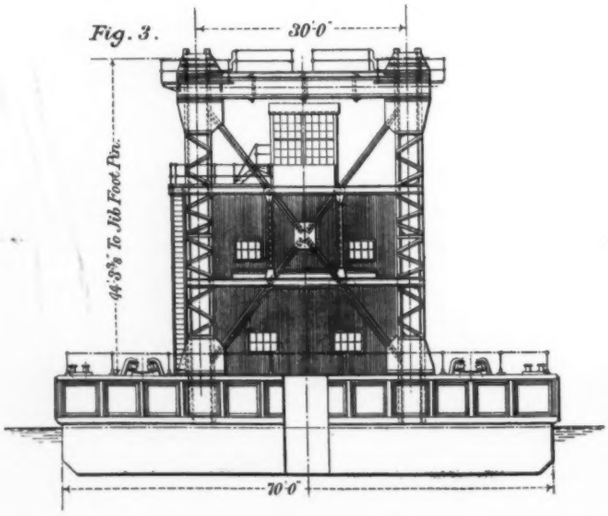
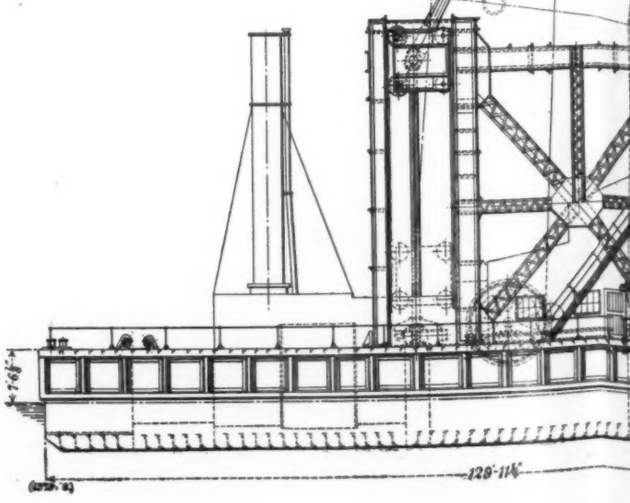


Fig. 3.

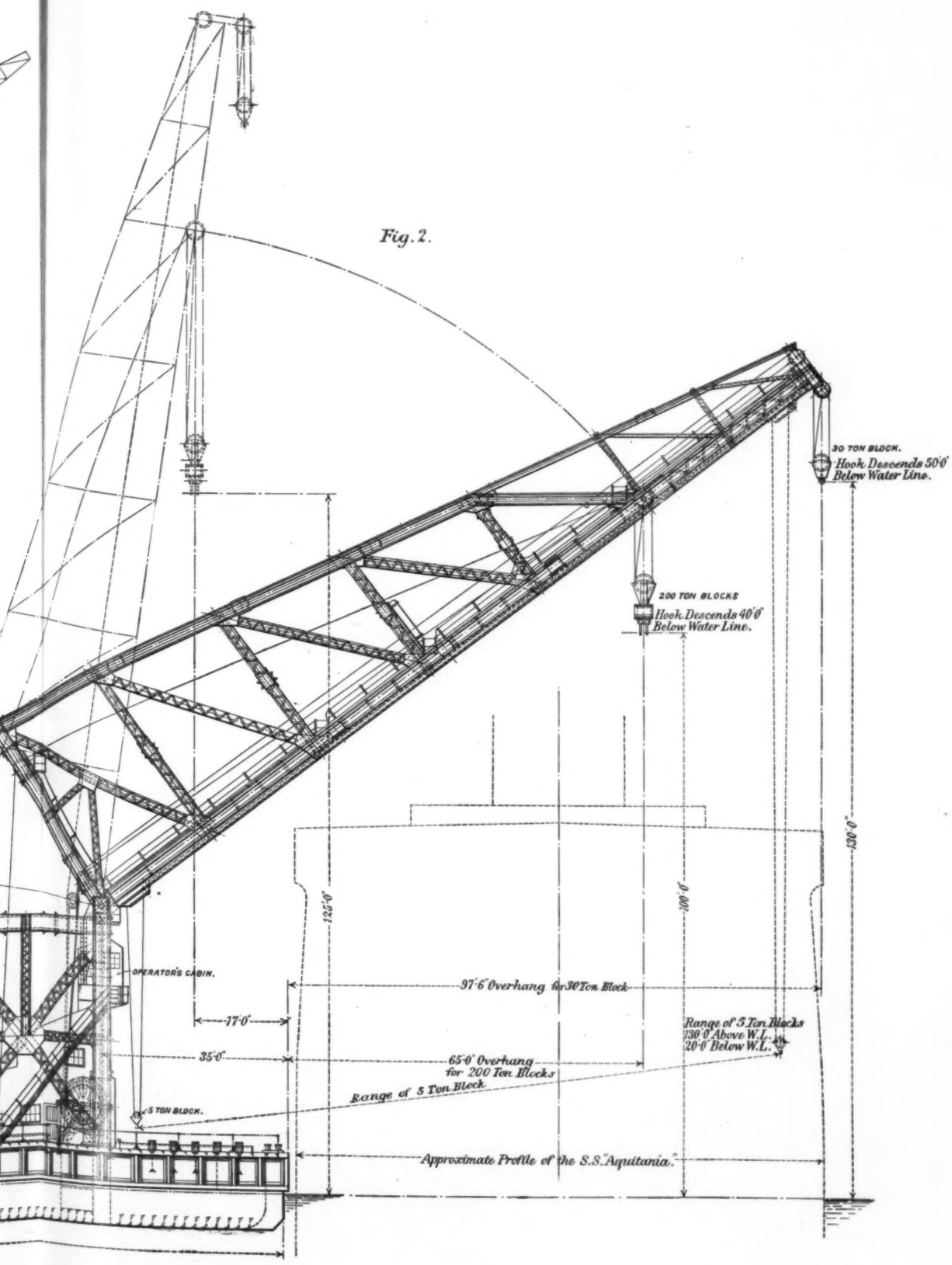




D SHIPYARD OF MESSRS. CAMMELL LAIRD AND CO., LIMITED.

Description, at Page 851.)

Fig. 2.



AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.
BELGIUM, Brussels: E. F. Satchell, 86, Rue du Tabellion.
CANADA, Toronto, Ont.: Wm. Dawson and Sons, Manning Chambers.
EDINBURGH: John Menzies and Co., 12, Hanover-street.
FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Agence Havas, 8, Place de la Bourse.
GLASGOW: William Love.
INDIA, Calcutta: Thacker, Spink and Co., Bombay: Thacker and Co., Limited.
ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino. And any post office.
LIVERPOOL: Mrs. Taylor, Landing Stages.
MANCHESTER: John Heywood, 143, Deansgate.
NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.
NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.
ROTTERDAM: H. A. Kramer and Son.
SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Cape Town: Wm. Dawson and Sons, 31, Long-street.
TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.
UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. For Advertisements, J. S. Allan, 30, Church-street, New York.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12s. per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any newsagent in town or country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£3 3 0
For Canada—	
Thin paper copies	£2 18 6
Thick ,, ,,	£3 3 0
For all other places abroad—	
Thin paper copies	£3 3 0
Thick ,, ,,	£3 7 6

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C. 2.

Offices for Publication and Advertisements 35 and 36, Bedford Street, Strand, London, W.C. 2.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8595 GERRARD.

CONTENTS.

	PAGE		PAGE
The Works of Messrs. William Foster and Co., Ltd., Lincoln (*Illus.*)	847	Notices of Meetings	861
Fourier, Bessel and Clifford	851	Gas and Electricity	863
200-Ton Steam Floating Crane (*Illus.*)	851	Organisation in Industry	864
Pelton Wheel Reconstruction (*Illus.*)	851	The Royal Society Soirée	864
Incinerator and Disinfector for Naval Service (*Illus.*)	854	The White Star Liner "Olympic"	865
Bench for Annealing Tests of Metals	855	The National Physical Laboratory (*Illus.*)	866
The Late Mr. Hammersley Heenan	855	Notes	868
Industrial Notes	855	Literature	869
The Determination of the Loads on Crane Wheels	856	Books Received	870
"Collision Dynamics"	857	Swiss Dynamometer Car (*Illus.*)	871
Naval Architects in Aeronautics (*Illus.*)	857	Yawing of Ships caused by Oscillation amongst Waves	874
Notes from South Yorkshire	860	The Specific Heat of Refractory Materials	875
Notes from Cleveland and the Northern Counties	860	Catalogues	875
Notes from the North	861	The Utilisation of Titaniferous Iron Ore in New Zealand (*Illus.*)	875
Notes from the South-West	861	Machine-made and Hand-made Silica Bricks	877
		ENGINEERING Patent Record (*Illus.*)	878

With One Two-Page Plate of the 200-TON STEAM FLOATING CRANE AT THE BIRKENHEAD SHIPYARD OF MESSRS. CAMMELL LAIRD AND CO., LTD.; and Four One-Page Plates of the WORKS OF MESSRS. WILLIAM FOSTER AND CO., LTD., LINCOLN.

NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. So long as postal rates remain as at present there will be no increase in the price of copies sent by inland post, which will continue at 1s. 2d. post free.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of Supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 861.

ENGINEERING.

FRIDAY, JUNE 25, 1920.

GAS AND ELECTRICITY.

THE gas and electrical interests have for many years been in direct competition in supply business, and a continuous controversy about the respective merits of each has been carried on. This controversy has of late tended to crystallise round certain papers and reports which have been prepared by Sir Dugald Clerk, and in order that the whole matter might be discussed in a fair way Sir Dugald arranged with Mr. Roger T. Smith, the president of the Institution of Electrical Engineers, that a debate should be held before that Institution. The arrangement was carried out on the 16th inst., when Sir Dugald and Professor Cobb presented the gas case and various well-known electrical engineers spoke for the other side. We do not know that the meeting threw much light on the matters which were discussed. This was probably because the whole agitation is a somewhat artificial one, and owes its existence not a little to the very able advertising policy of the British Commercial Gas Association.

It has been asked what case Sir Dugald Clerk has been trying to make in the various communications he has put forward in connection with this matter, and what it is that he wants engineers to do different from what they are doing. We are not in Sir Dugald's confidence in the matter, but it seems clear that he did not start the controversy and that his pronouncements are in the nature of replies to the coal conservation report which certainly favoured the electrical point of view. Looked at as a defence of the gas industry, Sir Dugald's papers are in every way allowable, although one may not in all cases accept his data. His conclusions, briefly, are that for heating purposes, and from the thermal point of view, gas is approximately four times more economical as regards the consumption of coal than is electricity, while for the supply of power it is 1·6 times as economical; but that for lighting it is inferior to electricity in the proportion of 0·84 to 1. These proportions refer to the average of current practice and not to the best results which can be obtained by either side.

The figures just quoted, particularly those relating to power supply, are disputed by many electrical engineers, and it is stated for instance that the figure which Sir Dugald has taken for the overall efficiency of an electric generating station is already out of date. Since accurate statistics on what is now actually being done in this country, as a whole, are not available, discussions about decimal points are of no value, and we need not here enter into details about the figure differences between the two parties to the controversy.

On broad lines we imagine no one is going to suggest that the conversion of coal to electrical energy and the re-conversion of that energy to heat is, or is likely to be, a normally efficient way of providing heat for industry. For special high-temperature purposes and in some domestic applications, owing to its convenience, electricity can make a case for heating, but otherwise the double conversion is obviously absurd from the thermal efficiency point of view. In this, as in other directions, electricity scores owing to its applicability. It may, of course, possibly be more economical from a financial and labour-saving point of view, in certain special cases, to employ electric heating even though from the actual coal-consumption point of view the proceeding is very uneconomical. Broadly, however, electricity is in general not likely to be used for heating purposes. The gas and electrical worlds, we think, both recognise this, and any real controversy between them turns on the overall respective merits of electric and gas stoves for domestic work. We need not follow them into this by-way.

On the question of lighting, Sir Dugald Clerk awards the palm in the matter of efficiency to electricity. We should again point out that the figures which he gave referred to the average of what is being done on both sides, and not the best which can be done by either. The average of what is now done can obviously at best only be guessed at, and someone else may easily guess differently from Sir Dugald. Mr. C. P. Sparks did so in the discussion before the Institution of Electrical Engineers. The figures on both sides being little more than personal opinions we do not think it necessary to argue about them. Quite apart from questions of efficiency, however, it is obvious that for the majority of lighting work electricity again scores owing to its convenience and adaptability. The absence of combustion and the products of combustion with both the vacuum and gas-filled lamp also to a considerable extent eliminates any deleterious effect on indoor decorations, and gives electricity a further point of superiority over gas. In any estimate which pretends to look at the rivalry between gas and electricity from the national point of view of labour-saving and coal conservation, this relatively greater deleterious effect of gas on outside work which at bottom depends on coal and labour should not be overlooked.

The great advantage which gas undoubtedly possesses in the competition from both domestic lighting and heating lies in the existence of an enormous system of mains and services. These are in being, and to a large extent have been paid for, and electricity, or any other newer type of competitor which depends on a network service, is necessarily at a disadvantage, in as far as it may possess a less complete network. Effective competition cannot begin until a fairly corresponding network has been laid. Such a network may certainly be laid and not paid for at once, but if the cost is capitalised the price of the commodity supplied must carry the corresponding amortisation charge.

On the question of power supply the controversy between gas and electricity again largely turns on matters of convenience and adaptability. In the driving of the machinery of a factory for instance, a gas engine installation makes a poor case against electric motors driven from the public mains. This type of comparison again brings in the question of extra and outside saving due to the employment of electricity. Mr. C. H. Merz, in the discussion to which we have referred, pointed this out. Speaking epigrammatically, Mr. Merz said "coal is labour." Enlarging on this he pointed out that if gas engines in a factory required more labour to run them than would electric motors, then the labour which was being saved on coal getting at one end of the gas train was being wasted at the other in looking after the engines, so that in the long run the gas argument for the saving of coal, which was equivalent to the saving of labour, broke down. There is much in this idea, but it hardly squares with the ideas of the coal conservation report of which Mr. Merz was one of the authors. The gas scheme may not save labour, but if it uses less coal it conserves some of our mineral wealth for the future. Mr. Merz did not point out, as we understood him, but it is arguable, although not provable, that the gas train in the long run uses as much coal as the electric train owing to the greater demands on repairs and maintenance, which in the end mean coal.

The power question as between gas and electricity

has an altogether different side, however. Gas is a fuel. Electricity, as Mr. Wordingham phrased it in the discussion, is a gearing. If the gas people can show that gas has superiority over steam for driving the engines which are necessary to make their gearing available they will have no objection to use it. On the contrary, they will be delighted to use it. The relative failure of the large gas engine has been a matter of much disappointment for many people in this country, but the electrical engineer must take facts as they are. At present our large electric supply stations practically could not be economically driven by gas engines. If that is not what the gas people want, and if what they rather aim at is the substitution of gas engines for electric motors by private users, one cannot say it could not in general be done, but allowing for increased maintenance and shafting losses which would necessarily be involved, one may safely say that on the whole a smaller overall efficiency would be attained and not a greater.

The conclusion of the whole matter appears to be that for many domestic purposes the field is fairly open to both gas and electricity and that the competition which now exists is likely to even further improve the appliances of both. Gas has an advantage in the existence of larger networks and those interested in its production are not likely to overlook this important point. For power supply in general we are afraid gas can make but a poor case against electricity, but for heating, matters are the other way round. Gas based on a calorific value instead of an illuminating one should be enabled greatly to extend its use in industry; but this extension would probably be at the cost, however, rather of solid fuel than of electricity.

ORGANISATION IN INDUSTRY.

Of the numerous problems with which employers are faced at the present day one of the most important is that of their relations with organised labour. It is clear that if the demands of labour are to be properly dealt with—if just demands are to receive proper consideration and unjust or unwarrantable demands are to be effectively resisted—the organisation on the employers' side must be in no degree inferior to that of labour. When the leaders of the railwaymen attempted last year to hold the State to ransom, the attempt was anticipated and defeated by the Government's organisation of road transport; but at the Coal Commission the mine-owners were obviously at a disadvantage for want of a proper constructive policy to be opposed to the demand for nationalisation of the mines, and at the Dockers' Inquiry the employers had to rely for the presentation of their case on an *ad hoc* or temporary organisation loosely and hastily constructed on the eve of the inquiry.

Employers cannot afford to ignore the wide powers which the Minister of Labour has under the Industrial Courts Act, 1919, of referring trade disputes to a Court of Inquiry and indirectly to the judgment of public opinion, and if the employers are to come successfully out of such ordeals they must be equipped beforehand with all the necessary statistics and information, the general line or policy to be pursued must be settled by some thoroughly representative body, and their case must be in all respects fully and adequately prepared. This cannot be done without proper organisation.

It is to be borne in mind that while employers have a duty to their workers in the direction of affording them proper working conditions and a fair standard of life, they have also a duty to the public to prevent the cost of living being unduly increased by excessive advances of wages; and here again the necessity of organisation and combination is obvious. Employers have also to reckon with the tendency on the part of trade unions to organise on a broad industrial basis instead of, as formerly, on the comparatively narrow craft basis. The unions of unskilled labour and of certain classes of semi-skilled labour are organised on even a broader basis than the strictly industrial basis, because they admit workers into membership irrespective of the industry in which they are engaged. In the manufacture of iron and steel certain of the unions in combination claim that they should provide all the necessary labour. Until now employers have organised on the craft basis, and it is a question for their serious consideration whether they should not organise on national lines so as to have closer connection of the different organisations in various branches of industry.

Organisation is necessary also in order that employers may be properly represented on Trade Boards and Industrial Councils, and the policy of these bodies co-ordinated. They are as yet only in the making and great developments of them may be expected.

In the recent award of the Railways National Wages Board a significant and important suggestion has been made. The Board record their view that the absence of any effective system of co-ordinating changes in rates of wages is largely responsible for the fact that wages settlements tend to be disturbed not because of inherent defects but because of changes in the comparative level of wages in different trades brought about without due regard to the position outside the industry immediately affected, and they suggest that every effort should be made to ensure that the movements of wages in the different industries should come effectively under review by a co-ordinating authority. It follows that one of the first steps towards co-ordination in the movements of wages should be the co-ordination of the employers' organisations in the different industries throughout the country.

In these days of industrial and commercial amalgamations there may be a few companies throughout the country who are strong enough to adjust their labour affairs direct with the unions, or even, as in he case of a large concern in the Clyde district, to ignore the unions and refuse to deal with them, and there may be cases of employers who hope to participate in the benefits secured by combinations of other employers without actually joining in the combination and bearing their share of the expense and contributing to the work; but a broad policy of organisation and combination on national lines is necessary if the interests of the employers and of the community are to be safeguarded.

THE ROYAL SOCIETY SOIREE.

THE second soirée of the Royal Society, the "Ladies' Night," held on Tuesday last, followed the first soirée* after an interval of more than the customary four weeks, and the day—a Tuesday, instead of the time-honoured Wednesday—was in itself exceptional. In a measure the soirée, which is, of course, an evening function, coincided in date with the annual inspection of the National Physical Laboratory which took place on the same afternoon. Though a number of the exhibits at the Royal Society were repetitions of the last exhibition, the novelties shown last Tuesday claim considerable attention.

Beginning with apparatus of general interest, we notice first the models illustrating the atomic arrangements in potassium chloride, ammonium chloride and also in tartaric acid, shown by Mr. W. Barlow, F.R.S., because these models concern the experimental work of Mr. Barlow on crystal structures to which Professor W. L. Bragg referred in his recent Royal Institution lecture.† Mr. Barlow accepts the structure as disclosed by W. H. Bragg and W. L. Bragg, and interprets it in his own way.

Among the exhibits of the Meteorological Office were rainfall maps of various districts and of the whole globe, one of them showing the oval district, mainly to the south of Louth in Lincolnshire, over which a rainfall of more than 4 in. was recorded during the recent disastrous rains. Two new instruments exhibited are due to Mr. L. F. Richardson of the Office. The first is a "Lizard" balloon for signalling automatically the height of a set ratio of air pressure to temperature. The rubber balloon itself acts as a pressure meter; it expands as it rises and presses more and more against a hood of chiffon which surrounds the balloon but does not stretch, until the pressure releases a trigger and causes the tail of a balloon to drop off (hence the name "lizard"). The balloon is previously tested at two volumes, and the ratio of these two volumes is determined. The second instrument, the photometer for determining the amount of water in clouds, is based upon the principle that the light transmitted by a cloud is decreased by the amount of water, liquid or solid, present in the cloud; the dust particles in a cloud will not be of much importance, except in very impure atmospheres. The photometer is a kind of telescope which is pointed to the sun; a side tube at right angles to the telescope is closed by a paper screen behind which a small lamp is mounted. By means of an iris diaphragm in front of the telescope, balance between the sun's image and the lamp image is established. The instrument can also be sighted at a stratus cloud.

The National Physical Laboratory had an exhibit explaining the measurements of lamp-filament temperatures by its method of colour identity, by an apparatus devised by Mr. J. W. T. Walsh. The life of a filament depends upon its temperature, and in gas-filled lamps the filaments attain much higher temperatures than in the older vacuum lamps. Within the visible spectrum the filament behaves approximately as a black body and the black-body temperature can be ascertained by a colour-match. The standard actually used is not a black body, but a vacuum lamp combined with a gelatine filter; the lamp is run at different volts, and the colour of its light is compared with that of the standard on a Lummer-Brodham bench; the temperature is deduced from the volts.

The other exhibits came from the Heat Department of the Laboratory. The apparatus for the determination of the thermal conductivity of poor conductors, a central hot plate, 1 ft. square, suspended midway between two surfaces maintained at any desired temperature by the aid of brine coils, was described by us last year. The new simple apparatus of Dr. Ezer Griffiths for determining expansion coefficients of metals, &c., at high temperatures will be noticed in our account of the work of the Laboratory. The duplex reversal key shown at the Royal Society, due to Dr. E. A. Griffiths, late of the Laboratory, reverses by one movement of a milled head the battery and thermocouple connections to a potentiometer. The instrument is a cylindrical ebonite box, the upper part of which consists of a glass case through which the copper plungers, etc., can be seen. Four amalgamated copper cups are fixed to the bottom of the key, and four copper plungers to the ebonite cover; midway between the cups and plungers is a moving platform carrying four cups with plunger prolongations. When the head is turned in one direction it brings the movable cups up against the fixed four plungers, when turned in the other direction it presses the prolongations down into contact with the bottom cups. The turning of the head is facilitated by a spiral spring which is so attached to the bottom of the case, outside it, that the movement to either left or right extends the spring, which pulls the key sharply over.

Various aircraft instruments were exhibited, both by the Air Ministry Laboratory and the Royal Aircraft Establishment at South Farnborough. The former exemplified four methods for the quick solution of spherical triangles for obtaining position lines from astronomical observation taken on the plane: the Nomogram of d'Ocagne, a slide rule based thereon, the Veater diagram and a slide rule based on the latter. The Wimperis gauge-bearing plate for measuring wind velocity and direction while in flight and Captain Weir's Littrow projection diagram (suggested by Commander Veater, R.N., for obtaining position lines) were also explained.

Among the exhibits of the Royal Aircraft Establishment were the R.A.E. bubble sextant of Mr. Booth, which is so arranged that the altitude of some heavenly body can be taken, independent of the orientation of the instrument, when the bubble appears in the centre of a red field. Further, several very useful gyro instruments. The gyro turn indicator, which tells the pilot when he is turning from his course, is mounted outside the fuselage; driven by the draught it can turn on a horizontal axis at right angles to the axis of spin. When the aeroplane turns about a vertical axis the gyro precesses about the horizontal axis, and the precession is carried by a shaft to a dial inside the

* See ENGINEERING, May 17, page 658 *ante*.
† See ENGINEERING, June 4, page 761.

fuselage; the amount of the precession is small, about zero, but every departure from that position brings larger and larger forces into play. The instrument is a tube with the rotor and dial at opposite ends and is due to Professor F. A. Lindemann, now of Oxford. The R.A.E. azimuth, a small cubical box, acts as a temporary compass, maintaining a constant azimuth. A small gyro carries a horizontal card; by means of a small compressor, driven by a windmill, the gyro speed is quickly raised to 20,000 r.p.m. The air is then turned off with the aid of a lever in front of the box, and the azimuth is read off. The R.A.E. air log comprises a large windmill, mounted on a strut at some place of least disturbance, the flow of air past the vanes is controlled by an adjustable shutter so that the speed of the anemometer bears a constant ratio to the aeroplane speed. The mill makes electric contact once every quarter mile; the pointer of a dial is then moved by an electromagnet. As an alternative the log may be driven by an air-pressure device embodying a Venturi tube.

Two other R.A.E. instruments—we do not mention them all—were of a different type. The R.A.E. soap film apparatus of Mr. A. A. Griffith is based upon the principle of the apparatus of Mr. Griffith and Mr. G. J. Taylor,* and the machine is to serve for obtaining solutions of Laplace's equations for calculating the stresses set up in the torsions and flexures of beams and in electric, magnetic and hydrodynamic problems. The other instrument is Dr. Bairsto's R.A.E. differential calorimeter for measuring the spark energy of electric ignition systems. The instrument forms a small vertical case (with glass front) in which two air thermometers, cylinders, more than 1 in. in diameter, are mounted; they are connected by a glass tube bent to a U, containing a liquid thread. The one cylinder contains the sparking electrodes, the other a spiral heated by a known current. The instrument will measure 0·05 watt within 0·5 per cent.

Messrs. T. E. Beacham and A. J. Boyd exhibited an apparatus metering fuel oil by counting volumes of oil into a supply tank; the unit capacity is adjusted to a definite weight, without reference to the density of the oil, by the aid of a water-displacement gauge.

Of the remaining exhibits which, so far as not noticed in May, were not numerous and mostly of biological interest, we mention the photo-micrographs of biological specimens taken in ultraviolet light by Mr. J. E. Barnard. Most micro organisms are sufficiently opaque to these rays to render staining unnecessary; and though the apparatus (now being mounted in the new National Institution for Medical Research, Mount Vernon, Hampstead) is exceedingly costly, it is also of the greatest promise. During the discussion on Microscopy by the Faraday Society last year, Mr. Barnard himself made it sufficiently clear that microscopy has advanced little during late decades, and can advance only by the use of special radiations, X-rays, ultra-violet light, &c. The photographs in question are taken in the light of sparks of cadmium, magnesium, &c., giving intense, well distributed lines. The spectrum is passed through a spectrograph, without a slit, of two quartz prisms (right and left-handed, not to introduce polarisation); the collecting lens gives an image of the spectrum practically in light of one wave-length; the mirror under the stage is replaced by a right-angled quartz prism; a diaphragm of uranium glass in the microscope serves merely for search purposes. The condenser under the stage, the slide and the cover glass of the specimen, and all the parts except the prisms, are made of fused quartz in order to avoid polarisation.

The two evening demonstrations of Radio-telephony were given by Mr. A. A. Campbell-Swinton, F.R.S., and the Marconi Company, as at the first Soirée.

THE WHITE STAR LINER "OLYMPIC."

To give anything like a complete account of the war work of the whole British mercantile marine would indeed be a formidable task, and to refer specifically to that of any one shipping company, or any particular vessel, renders the writer liable to a charge of partisanship. At the present time, however, when shipowners generally are subjected to considerable abuse on account of high freights and passenger rates, it is as well for the public to be reminded that the successful termination of the great conflict would have been impossible but for the courage and enterprise displayed by shipowners in pre-war days. We have little fear of contradiction in stating that no private organisation contributed more to the satisfactory result of the war than the White Star Line, or, to give it its correct designation, the Oceanic Steam Navigation Company, Limited, of whose vessels nine, totalling over 148,000 tons, were lost while engaged on war service. The greatest loss was, of course, the Britannic, of 48,158 gross tons, sunk by submarine or mine in the Aegean Sea, in November, 1916, while working as a hospital ship. It is perhaps rather remarkable, and it is certainly a matter for considerable satisfaction, that the Olympic, which is only slightly smaller than the Britannic, did not share the fate of the latter, since she was engaged for the greater part of the war as a transport ship for troops, and might therefore be regarded as a legitimate target for enemy submarines. The Olympic, however, not only escaped destruction, but was herself responsible for the destruction of at least one enemy vessel, having rammed and sunk the German submarine U 103 on May 12, 1918, near the entrance to the English Channel, while on a voyage from New York to Southampton with American troops. Another valuable service rendered to the nation by the Olympic was the rescuing of the crew of the battleship Audacious when that vessel was lost off the northern coast of Ireland in the early days of the war. Altogether the Olympic steamed 184,000 miles on war service and carried well over 200,000 persons. On one voyage as many as 8,000 troops were carried to Gallipoli.

It is now roughly a year since the Olympic was discharged from Government service, and in that time she has been reconditioned at the yard of the builders, Messrs. Harland and Wolff, at Belfast. The luxurious passenger accommodation, for which the vessel was justly noted, has been restored, the machinery overhauled, and the equipment improved in many respects. The work of reconditioning was commenced in September last, and by far the most important item, from a technical point of view, is the fitting of oil-fuel burning apparatus. The system adopted is that of Mr. W. A. White, of Pearl Buildings, Newcastle-on-Tyne, who supplied the apparatus which was fitted by Messrs. Harland and Wolff. In general the installation is similar to that on the Cunard liner Aquitania, referred to in our last issue on page 832. The main differences in the two installations lie in the methods of storing the fuel oil and also in the fact that the equipment of the Aquitania works with Howden forced draught, whereas natural draught is used on the Olympic.

It will be necessary, before dealing more fully with the latter installation, to give some general particulars of the vessel and her machinery, although as these have been illustrated and described in detail on pages 564, 620 and 693 of our ninetieth volume, we must refer our readers to those articles for a complete account. The Olympic, has an overall length of 882 ft. 9 in. and a length between perpendiculars of 850 ft. Her breadth over the boat deck is 94 ft., and her moulded depth is 73 ft. 6 in. Her gross register tonnage is 46,359, and her displacement on a draught of 34 ft. 6 in. is 60,000 tons. The propelling machinery consists of two four-cylinder triple-expansion engines, which drive the wing shafts, and a low-pressure turbine of the Parsons type driving the central shaft. The reciprocating engines each develop 15,000 h.p. at 75 r.p.m., and the turbine, which is driven by the exhaust steam from the reciprocating engines, develops 16,000 shaft horse-power at 165 r.p.m. The total horse-power is thus 46,000, and this gives the ship a speed of 21 knots. Steam is generated in 29 boilers of the ordinary marine type arranged in six boiler rooms, of which the four intermediate rooms each contain five double-ended boilers with six furnaces each. The forward boiler room, known as No. 6, contains four double-ended boilers and the after room (No. 1) has five single-ended boilers. The total number of furnaces equipped with oil burners is thus 159.

The Olympic is divided into 15 watertight compartments by transverse bulkheads, and it will doubtless be remembered that, as a result of the Titanic disaster, she was afterwards fitted with a double skin in order to render a repetition of that catastrophe impossible. At the time this work was carried out the possibility of using oil fuel was foreseen, and the space between the double skins was consequently subdivided and rendered generally suitable for oil-carrying. The part of this space which extends from the No. 6 boiler room to the centre part of the turbine room, has therefore now been used for oil storage, about 1,760 tons of oil being carried in this way. Altogether some 5,500 tons of oil are carried, the remainder being stored in athwartship bunkers formerly occupied by coal; no oil is carried in the double bottom of the ship. The athwartship bunkers, which are situated at the forward end of No. 6 boiler room and between boiler rooms Nos. 4 and 5 and Nos. 2 and 3, have been reconstructed, and rendered oiltight. The forward bunker is divided into three compartments, of which the central one is used as a settling tank, and a similar arrangement is used for the two other athwartship bunkers, except that these are also divided by the transverse bulkheads of the ship into four storage tanks and two settling tanks in each case. A separate settling tank has also been fitted in No. 1 boiler room, so that there are six of these tanks altogether—one for each boiler room. The fact that the settling tanks are all placed on the centre line of the ship prevents the varying level of the oil in them from having any effect on the stability or trim of the vessel. The other tanks in the athwartship bunkers are normally kept full.

The whole installation has been divided into three sections of two boiler rooms each, and each boiler room is provided with fuel pumps capable of supplying the whole of the burners in that room, as well as those in the adjoining room. For example, the burners in boiler rooms Nos. 1 and 2 can be supplied by either of the fuel pumps in room No. 1 or No. 2, drawing from the settling tanks in either of those rooms. The settling tanks, it should be mentioned are each of sufficient capacity to supply two boiler rooms for 12 hours. They are, of course, used alternately, the oil in one being allowed to settle, while that in the other is being drawn off. The settling tanks are fitted with Pneumercator gauges which indicate both the depth and weight of oil in each tank. They are also provided with steam heating coils, as also are all of the storage tanks. Particular attention has been given to the ventilation of the tanks. For this purpose a 12-in. air main, with connections to all the storage and settling tanks, has been installed, and air is delivered into this main from a fan on the forward part of the boat deck and discharged up a vertical shaft inside the after funnel, which is a dummy used for ventilation purposes only. A steam coil is fitted in the delivery trunk to heat the air and thus prevent the oil from congealing in cold weather. As to the efficacy of the ventilating arrangements we can testify from personal experience, it being impossible to detect the smell of fuel oil in any part of the ship.

An important feature of the White oil-burning system is the heating of the oil on its way to the burners, which heating the inventor considers essential for the proper atomisation of the oil. For this purpose it is passed, as mentioned in our article on the installation on the Aquitania, on page 832 *ante*, through tubular heaters supplied with steam. These raise its temperature to about 200 deg. F., which is 32 deg. above the flash-point. There are three of these heaters in No. 1 boiler room and four in each of the others; two are generally in use at a time, while the others act as spares. Filters, or strainers, are fitted between the fuel pumps, and the heaters, and also between the heaters and the burners. The pressure of the oil delivered to the burners can be varied from 60 lb. to 90 lb. per square inch, according to the power required, and the fuel consumption can also be altered by changing the burner nozzles, an operation which can be carried out in a few minutes. The normal full-power consumption is about 290 lb. per burner per hour, so that the total quantity of oil carried

* See ENGINEERING, December 21, 1917.

is sufficient for 11 days' steaming or for one Atlantic voyage with five days' supply in reserve. It is intended to take oil on board both at Southampton and New York, bringing the oil to the former port by tank steamer. It is considered to be more economical to transport the oil in this manner than to provide sufficient tank capacity in the Olympic for the double journey. The oil used is a petroleum residue supplied by the British Mexican Petroleum Company, Limited, and no difficulty is anticipated with regard to supplies. The whole quantity can be taken on board in about 6 hours, as compared with 4½ days required for bunkering coal. Two 8-in. filling connections, with which strainers are incorporated, are fitted on each side of the ship, and three transfer pumps are provided in boiler rooms Nos. 1, 3 and 5, for handling the oil on the ship. These pumps, which are of the Weir vertical direct-acting type, are provided with 10-in. suctions and 9-in. delivery connections, and the system of mains is such that they can draw from any of the storage or settling tanks and deliver to any other. Every precaution has been taken to avoid the possibility of fire in the stokeholds. Open-top gutterways are fitted round all tanks to collect any leakage which may occur, and steam jets are provided over the gutterways for fire-extinguishing. These jets can be operated from the upper deck, and emergency valves controlling the supply of steam to the fuel pumps are also fitted on this deck. To enable the engineers to check the working of the furnaces at any moment Cambridge platinum resistance pyrometers have been fitted in the uptake from each of the boilers. These pyrometers are connected to a multiple indicator on the starting platform and to another in the chief engineer's cabin, so that the temperature of the flue gases from any of the boilers can be ascertained, from either position, by turning a hand wheel to the number of the boiler it is desired to check.

A number of comparatively minor alterations affecting the safety and convenient working of the ship have also been made, but space does not permit us to deal with all of these in detail. We may, however, mention that the method of operating the watertight doors has been considerably improved. The doors are operated electrically from the bridge, on which an indicator is fitted to show the position of all the doors at any time. They can, however, be opened or closed locally in an emergency. For instance, if all the doors have been closed from the bridge, it is possible to open any one of them from either side by means of a switch, but, in this case, the door closes again automatically as soon as the switch is released. The doors can also be operated by hand gear, both locally and from the upper deck, indicators being provided on the latter to show the position of each door. Steel fireproof doors have also been fitted in every corridor on all the decks. A large secondary battery has been installed to operate the boat-lowering gear and other electrical appliances on the ship in the event of a failure of the main generating plant. Another new and interesting feature is the connection of all bath wastes and sanitary outlets in each watertight subdivision into two mains, one of which runs along on each side of the ship. These mains have a fall towards the centre of their lengths, at which point a single outlet valve is fitted; this valve can be closed from the upper deck in accordance with Board of Trade regulations. The new arrangement has eliminated nearly 300 connections through the skin of the ship.

The vessel left the builders' yard at Belfast on Thursday morning of last week, and, after preliminary steaming trials extending over about 8 hours, in Belfast Lough, proceeded to Southampton where she arrived in the early hours of Saturday last. Some fog was encountered on the voyage, and no attempt was made to attain the maximum speed, but we were informed that the whole installation had worked to the entire satisfaction of the superintendent engineer of the line, Mr. W. J. Willett Bruce, O.B.E., and also to that of the chief engineer of the ship, Mr. J. H. Thearle. The Olympic leaves Southampton and Cherbourg to-day for her first Atlantic voyage under the new conditions, and there can be little doubt that the popularity enjoyed by the vessel in pre-war days will be augmented by the improvements made.

THE NATIONAL PHYSICAL LABORATORY.

By invitation of Sir Joseph Thomson, the President of the Royal Society, visitors were admitted to the National Physical Laboratory on Tuesday afternoon last to meet the General Board of the Laboratory, of which he is chairman. This was the second annual inspection held since the war and, as was the case last year, the annual Report was not presented to the visitors. But Sir Richard T. Glazebrook was no longer present as Director of the Laboratory. Sir Richard retired last September and was succeeded by Sir Joseph E. Petavel, F.R.S., then Professor of Engineering at Manchester University. There have been other important changes in the staff and in the organisation of the Laboratory. Since the Report has not yet been circulated, however, we shall not deal with these changes and the work of the Laboratory during the past year on the present occasion, but shall confine ourselves to the demonstrations arranged for the inspection. They were certainly of great interest, but must, of course, not be taken as more than an indication of part of the research work conducted. We shall in this article refer to our previous reports; those of last year appeared in our issues of June 27 and July 11, 18, and 27, 1919. We begin our notice with the Engineering Department under Superintendent Dr. T. E. Stanton.

Fatigue and Impact Tests.—The new fatigue-testing machine for reversals of direct stress by means of an alternating magnetic flux works at up to 2,000 reversals per minute and has a range of load of ± 0·75 tons. The machine was constructed by Messrs. Brunton, Limited, of Musselburgh, to the design of Dr. B. Parker Haigh, who described this type of machine before the Institute of Metals in 1917.* The machine is now being calibrated in the Laboratory. To indicate its appearance in a few words, the machine consists of a vertical rectangular frame, supporting the lower electro-magnet, the armature, the upper magnet and the test-piece in such a manner, that the upper end of the test-piece is fixed to the top of the frame, whilst its lower end is fixed to the armature and is being pulled and pushed together with the armature, as two-phase currents are being passed through the coils. Dr. Haigh designed his machine in the first instance for the study of brass under various stresses, also corrosion stresses, but the quiet-working machine is of considerable general promise. With respect to Dr. Stanton's alternating stress testing machine (made in the department), especially designed for the study of the endurance of stranded cables and ropes, which we mentioned last year, we may say that Mr. Hankins has found camel-hair ropes remarkably resistant. The rope is wound round a pulley 2 in. in diameter in a few turns, and the pully is rocked to and fro' so that the rope is continuously being bent and unbent while being loaded to a certain fraction (about 0·1) of its breaking strength. The somewhat unexpected observation was made that the camel hair stood, under the same relative load, many times the number of oscillations to which the wire rope succumbed, so that the hair rope has more than 10 times the life and requires a much smaller factor of safety than the wire rope.

The new very simple machine for alternating-bending tests of thin plates is due to Mr. C. Jakeman, of the Laboratory, and was made there. The specimen, a strip of tinned iron or brass, *e.g.*, is pushed in between two dies of hardened steel, fixed by means of screws in a recess of a steel disc, a few inches in diameter, which itself is clamped in a vice. To the centre of this disc is pivoted a radial bar which the experimenter turns to the right and left. As he does so, a steel roller, mounted in the bar, bends the specimen over to the right or left, pressing it against the circumference of the disc. The thickness of the disc approximates to the width of the test piece, which will encircle less than 90 deg. when bent to either side. After, say, 20 reversals, the specimen will break, and this number is counted. In order to adjust the machine to specimens of various thickness and toughness, the roller can be slightly displaced on the radial arm and the dies, which grip the specimens, are rounded off to different radii at the edges round which the specimen is bent.

The new Guillery impact testing machine has been presented by Sir Robert Hadfield. The double pendulum machine for impact tests, devised for the Notched Bar Committee of the Engineering Standards Association by Dr. Stanton and Mr. R. G. C. Batson, was mentioned last year. It is a fall-hammer machine for high variable speeds. Both the tup and the anvil (forming a U through which the tup passes) are pendulums, 4½ ft. long, and can be raised to angles of 130 deg., the one to the left, the other to the right, to be released at the same moment. The striking velocity can thus be increased from 9 ft. up to 43 ft. per second. This increase in the striking velocity has, in the case of some materials, a marked influence on the work done in fracture, but there is hardly any such influence in the case of hard steel; this latter material has hence been studied in the first instance to simplify the complex problems.

Journal Friction at High Temperatures.—Mr. Jakeman's other machine, which we illustrate in the diagrams, Figs. 1 to 3, page 867, is designed for determining the coefficient of friction of shaft bearings of various types (plain, ball, roller), which have normally to run at high temperatures. The shaft A, of 4 in. diameter, is turned down to 2 in. near its end; over this portion is placed the bushing B fitted tight in a steel ball which is pressed upon by the holder H, all these parts being surrounded by the sheet-iron case C. Through C and H passes the feed pipe for the oil to be tested; the pipe contains also a thermo-couple. The shaft itself is bored out as shown, and into the bore reaches the mouth of a forced-draught gas burner; the inner wall of the shaft serves as a chimney for the gas flame, and holes drilled through the shaft in the way indicated in Fig. 1 allow the hot gases to pass through the shaft and to enter the casing, thus completely surrounding the bearing and keeping it at about 350 deg. C. The experiments are performed with the aid of the Laboratory machine for testing the friction of bearings which we described on a previous occasion, while the bearing is rotating at 1,500 r.p.m. under load. The arrangements adopted for loading are explained in Figs. 2 and 3, which are on half the scale of Fig. 1. The cast iron frame bears with its two ears on two knife-edges, the points of support being in line with the centre of the shaft. Two vertical bars extend from the ears down to a similar bar on which three knife-edges are seen (Fig. 2); from the central edge (which is not inverted like the other two) is suspended the lever to the end of which the load is applied; the lever ratio is 12 : 1, so that a load of 10,000 lb. on the bearing requires an actual weight of 833 lb. With the arrangement adopted the points of applying the load will always remain in line with the centre of the shaft, when the frame is tilted during torque measurements. The torque arm, which has a length of 3 ft., is weighted as indicated to balance the friction torque. It will be understood that the shaft is alone rotating; the loading frame, the ball and bearing are all stationary except for the small motion allowed by the balancing arm. The oil pipe acts also as a stop to prevent the steel ball from running round in the cast-iron holder when the journal friction becomes high.

Gear-Testing.—A 1-h.p. model of a machine for determining the efficiency of spur and bevel gears, chain drives, &c., also attracted considerable attention. The machine, which Dr. Stanton himself recently described in our columns,* is of the Lanchester gear-test type and determines directly the ratio of the torques of the driving and driven shafts, the actual measurements being very simple.

Friction and Lubrication.—Mr. R. M. Deeley's machine for determining the coefficient of friction of surfaces in contact was briefly described in our account of the discussion on Lubrication by the Physical Society last November,† The machine is being studied by Mr. J. H. Hyde, who last spring gave an account to the Royal Society of the work done with the machine, designed and constructed by

* See ENGINEERING, September 21, 1917, page 315.

* See ENGINEERING, March 12 last, page 334.

† See ENGINEERING, December 5, 1919, page 758.

Dr. Stanton and himself for the determination of the absolute kinematic viscosities of liquids at high pressures. The research was conducted for the Committee on Lubricants and Lubrication and will be more fully dealt with in due course. We have already described this ingenious machine, and will on this occasion only mention that the research necessitated independent measurements of variations of density with pressure for water and the oils experimented with. Mr. Hyde has gone up to pressures of 11 tons per square inch; a pressure of 1 ton per square inch is roughly equivalent to a pressure of 150 kg. per square centimetre. The experiments were made at 20 deg. and 40 deg. C. (also at higher temperatures) with various oils (animal, vegetable, mineral) and with water. The results agree with previous data, so far as available. The viscosity increased in all cases, as the pressure rose, especially above 500 kg. per square centimetre; but the mineral oils, while strongly differing among themselves, showed much greater increases than the other oils. Comparing the viscosity at ordinary pressures and at 900 atmospheres, the viscosity increased for the mineral oils up to 20 times, whilst only three or four times for the other lubricants. As regards the change of density, the increases with rising pressures were in all the cases small, regular, and of the same order.

Dynamometer.—Mr. Hyde is also in charge of the experiments with the plough and tractor dynamometer which is to be used in the competitive trials which are to be carried out this year by the Royal Agricultural Society, near Lincoln; the instrument was designed in the Laboratory. The device consists of a hydraulic pull-bar, fixed between the tractor and the plough, and a recorder which is placed on a wheelbarrow; the barrow is pushed along by a man walking by the side of the tractor. The dynamometer is cylindrical; the pull on the plunger in the cylinder forces oil through a gland, and the pressure of this oil is recorded by a Bourdon gauge on the indicator drum of the recording instrument; this drum is driven by a belt fixed over one of the wheels of the barrow.

Gas-Detonation Pressures.—Mr. R. W. Fenning's apparatus for investigating the effect of pressure and temperature in the detonations of gases is finally to help to elucidate the internal-combustion engine problems. So far the work has been confined to explosive mixtures of hydrogen with air and oxygen. The explosion cylinder is closed above by a horizontal diaphragm. Against this diaphragm presses, under the action of a spring, a vertical rod which is joined to a lever and a bar rocking about a horizontal axis; to the bar is attached a small mirror. On this mirror falls the beam from an arc lamp which passes through a small hole in a brass disc; in front of the hole oscillates, in a vertical plane, a tuning fork, the wirelike projection of one of the prongs closing the hole at each of its 500 oscillations per second. The brass disc closes a horizontal drum rotating at constant speed; a ray passes along the axis of the drum to a prism which sends the ray on to the mirror from which it is reflected back to the screen of a photographic camera. This screen is opaque, except for a vertical slit, up and down which the image of the arc (the reflected ray) oscillates rapidly while the mirror is being rocked with its bar by the explosion. Thus a photographic curve of the mirror movements and pressure variations is obtained. With mild explosions the curve rises gradually to a maximum; the rise is regular, but it generally marks two periods of acceleration. With violent explosions the first pressure oscillations are very strong; pressures of 800 lb. per square inch have not been exceeded so far. The inertia of the moving masses is very small, but its influences and the spring effect have to be eliminated. In order to secure an efficient mixing of the gases without the use of a stirrer, necessitating a stuffing-box, Mr. Fenning lets the two gases (from cylinders) enter a larger steel cylinder, the lower portion of which he immerses in hot water

Fig.1.

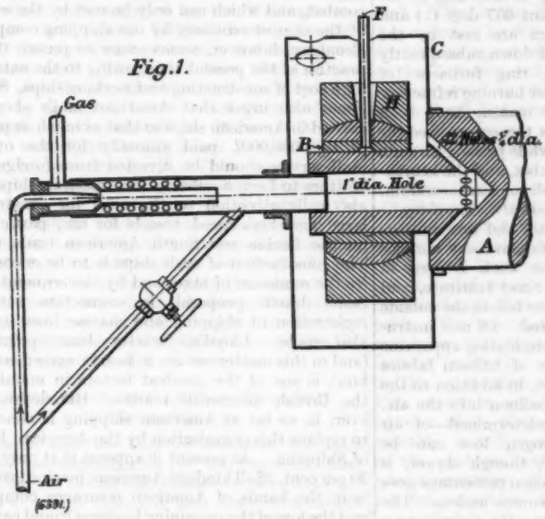


Fig.2.

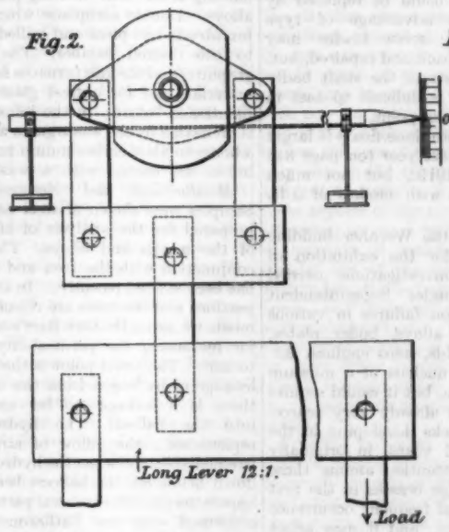
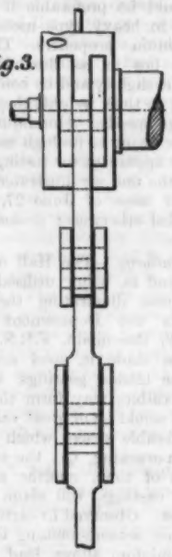


Fig.3.



Fire-proofing of Magnetos.—The apparatus for the fire-proofing of magnetos (Mr. Hankins) is simply a cylindrical chamber, in which the magneto is so mounted that it can be driven by a shaft entering through a stuffing-box at the end. The chamber is evacuated and then charged with the explosive gas mixture. Magnetos for flying craft have to pass this test, and they do pass it mostly; in the early war days some mishaps were perhaps too readily ascribed to magneto-sparking.

Skin Friction of Air.—Two appliances for measuring the skin friction of air passing over smooth surfaces were explained by Dr. Stanton and Miss D. Marshall. In both Pitot tubes and differential hydraulic gauges are used. In the first investigation the object is to determine the friction and the condition at the boundary of a fluid in turbulent motion by means of observations of the velocity distribution over the surface. These experiments are made with air flowing at widely differing rates through long pipes, about 0·25 cm., 0·7 cm. and 12·5 cm. in diameter. The flow of fluid not in the immediate vicinity of the surface is turbulent, but little is known as to the mechanism by which the resistance to flow is transmitted to the bounding surfaces. For speeds below the critical, when the general motion of the fluid is stream-line, it is generally believed that there is no slip in the boundary layer of fluid. For speeds above the critical it is assumed that there is a thin layer in which the flow is laminar. The exploration of these conditions, which have been investigated in the Laboratory for a good many years, is very difficult for the important reason that even the finest Pitot tubes may disturb the phenomena by their mere presence. It was recently found that, when approaching the pipe wall within, say, 0·1 mm., the ordinary Pitot tube could not be trusted, and the device was adopted of removing the wall of the tube which would be close to the pipe, and of letting the pipe wall itself act as one of the walls of the tube, which was square in section. By these means it has been established that for high speeds, far above the critical, there is indeed a layer of fluid of finite thickness which is in laminar motion.

In the second research, measurement of the skin friction of air passing over very smooth, thin flat plates, the momentum of the air is observed. The metal plate is placed in a wind channel, with its plane vertical and parallel to the air current, the plate being mounted on a vertical rod which can be turned in its socket. The plates used are rectangular, from inches to feet in lengths, and their edges are sharp. The Pitot tubes are used in pairs, one being near the front edge, the other near the rear edge of the plate, so as to determine the loss of momentum over the length of the plate; the frame of the tubes is moved so that the Pitot orifices traverse the plate at various distances from the plate. For plates about a foot long any plate influence is found to be no longer observable at a distance of ¼ in. from the plate; for smaller plates this range is smaller.

Aeronautics.—Various demonstrations had been prepared by Mr. E. F. Relf in the No. 1 and No. 3 wind tunnels (both 7 ft.) to exemplifying the determination of the performances of air screws, the reaction of the plane body or airship car on the airscrew, the stability of complete aeroplane model and special problems. The new tunnel, 7 ft. by 14 ft., which is now nearly complete, was also open for inspection.

The William Froude National Tank.—Mr. G. S. Baker, Superintendent of the Department, had only arranged three exhibits, but two of these were novel and of considerable interest. The first illustrated his experiments on the effects of loose oil in the large compartments of oil-cargo steamers, the particular object being to determine the pressure on bulkheads due to the effect of pitching. The investigation is conducted for Lloyd's Registry. On a long swinging arm, built up of angle irons, is placed a steel tank, 4 ft. by 1 ft. by 1 ft., representing a section of a tank steamer, fitted with bulkheads and other obstructions to the motion of the oil in the compartments. The bulkhead to be experimented on is perforated with several holes (there were nine in the model shown), each an inch in diameter; the hole is closed by a metal diaphragm (of phosphor bronze, *e.g.*) against which a vertical rod bears. This rod at its upper extremity, moves a mirror; a beam of light falls on the mirror and is reflected back on a strip of photographic paper pulled through a camera. When the arm is pitched at rates of one complete oscillation in 3 seconds, 4 seconds or 7 seconds, a wave curve is obtained from which the stress can

be deduced. Some of the early curves shown marked considerable embroidery on the regular wave form; these rapid oscillations are probably due to imperfect balance of the arm, which is one of the difficulties of this research.

The other apparatus has been devised for testing the effects of a screw propeller on its ship, and the experiments are made in the large tank of the Department. The ship model used represented a single-propeller cargo steamer, the propeller being an 8-in. screw which would correspond to an 18-ft. propeller. Behind the truck which pulls the ship in the tank is the gear carriage, which is now so provided with various gears that one, two, three or four shafts can separately be driven from one electric motor, each of the shafts giving its own record on the drum; the quadruple shaft drive is not yet quite complete. In the demonstration the screw was brought up to the boat with its shaft attached to the parallel motion so as to turn behind the boat in ordinary fashion. The motion of the screw must increase the resistance to motion of the boat, and this is the point under investigation. The screw also strains the ship, and for this reason it would be preferable if the screw models, now made in heavy type metal, could be replaced by aluminium propellers. The advantage of type metal lies in its flexibility; screw blades may be bent slightly and be bent back and repaired, but, owing to their weight, they strain the shaft badly at high speeds. Aluminium is difficult to cast in plaster owing to its high melting-point.

The apparatus for testing seaplane floats is larger than the one we illustrated last year (on page 848 of our issue of June 27, 1919), but not much modified otherwise; it deals with models of 5 ft. length.

Metallurgy.—The Hall of the Wernher building was, and is, being utilised for the exhibition of specimens illustrating the investigations carried out in the Department under Superintendent Dr. W. Rosenhain, F.R.S., on failures in various articles made in steel and alloys, boiler plates, turbine blades, gearings, welds, aero engines, &c. The exhibits may form the nucleus of a museum which would be of great value, but it would require considerable space, which is already very scarce. Season-cracking, *i.e.*, the cracks developing in the course of time, months and years, in originally sound castings, will claim attention among these failures. Observed in cartridge brasses in the first instance, season-cracking is of frequent occurrence in aluminium alloys, lead, &c., and it may affect cold-worked alloys and metals generally; Dr. Rosenhain recently presented to the Royal Society an account of the investigations made by himself, in conjunction with Messrs. S. L. Archbutt, Hanson and Tritton.

Rolling Mill. Alloys, Constitutional Models. Thermo-couple Protectors.—The most interesting demonstration given in the rolling-mill building concerned manganin (copper - nickel - manganese) which is now made in the Laboratory in rods of 1¼ in. diameter and rolled down in three stages to wire and to thin sheets. Manganin is very hard and has to be rolled cold as any heating might lead to a partial annealing, which is one of the great difficulties of successful manganin manufacture; we shall refer again to manganin in our comments on the Electrotechnical Department. The rolling mill of the Laboratory has proved so signal a success in the study especially of light alloys, which could not have been conducted without the mill (it has recently utilised for making very thin sheet metal as well) that the appeal of the Department for a wire-drawing plant should meet with a favourable reception. The arrangements of the metallurgical microscopes for visual examination, projection and photography, and for the illumination of the specimens also by oblique coloured beams, have been noticed on recent occasions. New were the models illustrating the constitution of alloys by the aid of wires painted in various colours and mounted in glass cases; the models take the place of the bulky moulded models and are far more lucid than two-dimensional equilibrium diagrams. The models exhibited exemplified the constitution of alloys of aluminium with zinc and copper, and with magnesium and silicon. Other novelties were the fine refractory tubes for the protection of thermocouples. These tubes are made in the Laboratory from mixtures of China clay with pipeclay and also alumina, mostly in proportions of 80 : 20 of the first two materials mentioned. The well-mixed paste of fine particles is extruded through a die and delivered on a band travelling at a speed concording with the delivery speed so that the tubes, only 1 mm. or less in diameter, remain perfectly straight and uniform. Though very thin-walled, the finished tubes bear the full temperature to which the thermocouples may be exposed, namely, 1,650 deg. C.

Foundry.—The new equipment of the foundry comprises a crucible presented by the Morgan Crucible Company, of Battersea, to the Laboratory. The crucible is of the type we described last year,* the crucible material, a mixture of graphite and clay, being directly heated by the current flowing through it. The crucible can be tilted in its cradle, and has the form of a pot fitted with a spout and a short neck ring round which the upper, water-cooled, electrode fits, the lower electrode being also water-cooled. The furnace is fed with alternating current and is used heated up to 800 deg. C. for melting aluminium (melting-point 657 deg. C.) and alloys. Double aeroplane wings are cast in the foundry in one piece and milled down subsequently to the desired camber. The ring furnaces (of graphite) and the kiln furnaces for burning refractory materials and for optical glass making have been mentioned before; in the kilns the compressed air is preheated by the waste gases while passing through a honeycomb of carborundum tubes, and the hearth-bricks are coated with a wash of carborundum.

Metallurgical and Aeronautical Chemistry.—Samples were shown of steel bars and fine millings prepared for the analysis of standardised samples of the metals and alloys. The work is done in conjunction with the Iron and Steel Institute, and has been started recently. In the billets the outside portions and the cores are rejected. Of new instruments we notice Dr. Guy Barr's circulating apparatus for measuring the permeability of balloon fabrics to air. The novel point is that, in addition to the leakage of hydrogen from the balloon into the air, there is a leakage—so far undetermined—of air into the balloon. The hydrogen loss can be replenished; the inflow of air, though slower, is irremediable, and when the hydrogen percentage goes down below 80, the balloon becomes useless. The apparatus consists of several parts: the permeameter combined with one katharometer; the circulator (pump and furnace); the bridge and second katharometer; and the indicator which resembles a galvanometer and is calibrated in percentages of hydrogen. Every determination requires several observations and takes several hours, because the diffusion is slow. The permeameter, a shallow gun-metal box, is horizontally subdivided into a upper and a lower chamber. The katharometer, attached to the lower chamber, is a metal block into which two small cylindrical cells are bored; the one is permanently filled with air, into the other the gas mixture enters; each cell contains a spiral of very fine platinum wire which is heated by a battery and cools more rapidly in a light gas like hydrogen than in any heavier gas; the resistance ratio of the two spirals, measured on the Wheatstone bridge, is thus a measure of the gas density and indirectly of its composition. In the first test the upper chamber is filled with hydrogen which, diffusing through the fabric, passes into the lower chamber and into the katharometer. In the second test air is drawn through the lower chamber, passes upward and out into the second katharometer and the circulator, which is a system of glass tubes constituting a Sprengel pump. The Wheatstone bridge is contained in a small case to which the second katharometer is attached. A third determination is wanted because the katharometer does not well distinguish between nitrogen and oxygen, which are almost of the same density, and because nitrogen diffuses through a fabric at a faster rate than oxygen; for this determination the gas current from the upper chamber is first sent through a small furnace, a silica tube wound with nichrome wire in which the oxygen of the gas mixture is burnt out. Katharometers (due to Dr. G. A. Shakespear) are now used in various instruments, and are very convenient, though their very fine spirals require occasional recalibration.

(To be continued.)

* See ENGINEERING, of March 28, 1919, page 416.

NOTES.

AMERICAN MERCHANT SHIPPING SUBSIDIES.

ALTHOUGH we are not acquainted with the exact terms of the Merchant Marine Act of the United States, which became law on the 5th inst., it was evidently drawn up with the object, laudable enough from the American standpoint, of developing the shipping of that country and protecting it from foreign competition. Foreign competition, in this case, is mainly British competition, and, for this reason, the matter must be carefully studied by the shipping interests of this country. From the statement of the chairman of the Senate Committee on Commerce, Senator Wesley L. Jones, reported in *The Times* of Tuesday last, it is evident that the Act provides for preferential railway rates to assist American export shipping. This is a form of aggression which will be particularly difficult to combat, and which can only be met by the exercise of the utmost economy by our shipping companies. Economy, however, seems easier to preach than to practise at the present time, owing to the extremely high cost of constructing and working ships. Senator Jones also urges that American mails should be carried in American ships so that as much as possible of the 600,000*l.* paid annually for the overseas mail service should be diverted from foreign competitors to form a subsidy for American ships. He also calls attention to the need for constructing large and high-speed vessels for use, particularly, on the Pacific and South American trade routes. The construction of such ships is to be encouraged by the remission of taxes and by Government loans. Some drastic proposals in connection with the registration of shipping and marine insurance are also made. Lloyd's, Senator Jones points out (and in this matter we are in hearty agreement with him), is one of the greatest factors in maintaining the British mercantile marine. His desire, however, is, as far as American shipping is concerned, to replace this organisation by the American Bureau of Shipping. At present it appears that only about 30 per cent. of all kinds of American marine insurance is in the hands of American insurance companies, and the loss of the remaining business would certainly be felt in this and in other allied countries. The position has already created some disturbance at Lloyd's, the majority of underwriters having decided to transact no further American business for the time being. This action, however, strikes us as rather playing into the hands of our rivals. With regard to registration the position held by Lloyd's may be gathered from the fact that, of the steel steamers launched in the whole world during 1919, 65 per cent. of the tonnage was intended for classification in Lloyd's Register Book. In this respect, at all events, it really seems that we may regard the American bid for supremacy with some degree of complacency, but in other matters connected with the industry it is evident that British shipowners and shipping concerns must take careful stock of their position if we are to remain the main carriers of the world's goods.

SUBAQUEOUS CAMERA IN FLOODED FRENCH MINES.

A particularly interesting application of subaqueous photography has been made by the French Government in connection with the restoration of the flooded collieries in the Lens district. It appears that, before their retreat, the Germans not only flooded the mines but also set traps for the purpose of hampering the operations for their recovery. These traps were certainly effective in retarding the work of reconstruction, and were the cause of a number of serious accidents to the men engaged in the work. In order to detect these traps, and so avoid as far as possible the occurrence of accidents due to concealed works of destruction, the French Government decided to employ subaqueous photography to examine the linings of the shafts and so discover the positions of punctures. The work of constructing the subaqueous camera employed for the purpose was entrusted to Messrs. Siebe, Gorman and Co.,

Limited, Westminster Bridge-road, London, S.E. 1, on account of the large experience this firm possesses in work of a similar character. The apparatus employed consists of three main castings of gun-metal, bolted together one above the other, and measuring 3 ft. 4 in. by 3 ft. 4 in. by 4 ft. 9 in. high; the weight of the whole apparatus amounts to 15½ cwt. The upper and lower castings are each formed with four watertight chambers each closed by a plate glass window, and containing a quartz mercury vapour lamp of 3,000 c.p. There are thus eight of these lamps, the light from which is projected horizontally in all directions, and the total candle power is therefore 24,000, but it must be remembered that the light from mercury-vapour lamps is extremely rich in actinic rays and is therefore more effective for photographic purposes than other lights of equal intensity. The central casting has four chambers in which the lamp resistances are mounted and four smaller chambers containing the cameras, the focal axes of which are set at right angles in a horizontal plane. The whole apparatus is suspended by slings attached to four lifting eyes formed on top of the upper chamber, on which a junction box for the cables is also fitted. The lamps, which were supplied by the Westinghouse Cooper-Hewitt Company, Limited, burn in parallel on a 200-volt direct-current circuit, and take about 3½ amperes each. They have been made of the simplest possible construction and are tilted, for starting, by means of levers actuated by rods on the outside of the chambers. These rods pass through watertight stuffing-boxes, as also do the electrical leads to the lamps. The cameras are of the box type with very wide angle lenses and electrically-operated shutters fitted behind the lenses. It will be obvious that by suspending the camera in the axis of the shaft, pictures covering the whole of the circumference can be obtained in a single exposure, and, by repeating the operation at different levels, the whole interior surface of the shaft can be examined without risk. In this way the French officials hope completely to overcome the malevolent intentions of their enemies.

Bicentenary of the London Assurance Corporation.

Insurance and the idea of insurance are such everyday accompaniments of ordinary life that it is not easy to realise that it was ever done without. Clearly, to a large extent, it was, however, although the idea and the practice go back to a very different time from that in which we live. These more or less contradictory reflections are illustrated by the falling of the bicentenary of the London Assurance Corporation on Tuesday last. This historic organisation was established by Royal Charter on June 22, 1720, and to commemorate the bicentenary a brochure dealing with its early days has been published by the corporation. It has been written by Mr. G. S. Street with considerable grace, and forms an interesting souvenir of an occasion of which any organisation might well be proud. The age of the London Assurance is brought very clearly to one's mind by Mr. Street. The year 1720 sounds a long time ago, but a more acute idea of the long time it is is conveyed when Mr. Street points out that the present London Assurance with offices at 7, Royal Exchange, E.C. 3, was established when Pope and Swift were alive and had still twenty years to live, when Dr. Johnson was but eleven years old and David Garrick only four. In those days the Tyburn River flowed across Piccadilly and one had to cross by a bridge. The year of the founding was the year in which the South Sea Bubble ended. A little real insurance was perhaps not out of place in those days of "high finance," but in such an atmosphere of speculation the founding and carrying to success of a sound insurance business cannot have been a simple matter. Insurance seems to have been in the air at that time and schemes were many, but success like that of the London was rare. Its founders must have laid the first stones well, and a continuously sound policy has led it to its bicentenary. We offer the Corporation our congratulations. The London Assurance is not an engineering organisation, but we can claim some kinship with it in the early work and the continuous work it has done in connection with fire fighting. That work, and the appliances it called for has led to the modern fire engine and its auxiliaries.

Motor Vehicle Taxation.

The proposal to abolish the tax on motor spirit and to impose in lieu thereof a vehicle tax based on horse-power continues a subject of considerable adverse criticism. The equity of any such measure has been justly challenged on the ground that it would operate to the advantage of the regular car user at the expense of the occasional user. It is obvious that the former, taking as he does more out of the roads than the latter, should be called upon to pay more towards their maintenance. Yet under any form of vehicle tax this important factor of car mileage is neglected, and the amount the individual motorist has to pay ceases to be proportionate to the damage he does to the roads. A tax on motor spirit, on the other hand, is virtually a tax per horse-power per mile run, and since the wear inflicted by a car on the roads is roughly dependent on the power of the car and the distance it runs, a tax on the spirit used would, in effect, bring the charges incurred by the individual motorist into direct proportion to the amount he takes out of the road. This is surely a fairer basis of taxation. It is endorsed by the recommendations contained in the interim report of the Departmental Committee on the Taxation and Regulation of Road Vehicles, presided over by Sir Henry Maybury, the Chief of the Road Department of the Ministry of Transport. This report advises that the taxation of motor spirit should be continued, and suggests that a flat rate of 4*d*. per gallon should be levied on all imported spirit. That these recommendations were not, however, entirely acceptable to the Government is to be inferred from the fact that the report in question was referred back to the committee by the Minister of Transport, and that the taxation of self-propelled road vehicles is dealt with in Mr. Chamberlain's Budget proposals on a horse-power basis. The rejection of the committee's recommendation is a suggestive commentory on Sir Eric Geddes' methods. The reason for his action in this connection is somewhat hard to fathom. The report in question embodied the considered opinion of a strong committee which was presumably, in full possession of all the facts relevant to the problem, and in receipt of all the expert advice necessary. The equity of its finding is self-evident. Another factor which should not be overlooked is that a tax on imported motor spirit would stimulate home production—a very important consideration from a national point of view. It might, it is true, be urged that the majority of commercial motor users support the Government scheme, but even this contention is open to question. A horse-power tax in lieu of a tax on spirit would undoubtedly be supported, from purely selfish motives, by the owners of large fleets of commercial motor vehicles whose cars are on the road every day and all day. But with the small owner it is not so. Out of 4,000 small garage proprietors and commercial car owners who were questioned on this point by the Motor Legislation Committee 98 per cent. were in favour of a retention of the petrol duties at a flat rate. It would therefore seem that a large majority of commercial car owners as well as the majority of private motorists, who are strongly opposed to the horse-power tax, are antagonistic to the Government scheme, and that only the large commercial car owners favour it. Granting this, and granting also that the requisite revenue can be obtained from the petrol tax—a point which has not been seriously questioned—it is surely obvious that the Government should reconsider the whole matter, and endeavour to place the taxation of motor users on a fairer basis than that embodied in their present proposals.

Personal.—Mr. H. M. Rounthwaite, who for the past seventeen years has filled the post of mechanical engineer to the London County Council, retired from that position on Wednesday last, the 23rd inst., under the age clause regulations. Mr. Rounthwaite's address is now 12, Holmbush-road, Putney Hill, London, S.W. 15.—Messrs. J. W. Jackman and Co., Limited, announce that their offices at Caxton House having been vacated by the Government, their addresses will in future be as follow: Caxton House, London, S.W. 1, and Vulcan Works, Salford, Manchester.

LITERATURE.

Coal Mining and the Coal Miner. By H. F. Bulman, M.I.Min.E., Assoc.M.Inst.C.E., F.G.S. Illustrated. London: Methuen and Co. [Price 15s. net.]

In this work many facts are collected, and the author's intimate acquaintance with the various problems that concern the miners welfare is clearly evidenced. Also he is not unmindful of the interests of those by whose enterprise and capital mining has acquired the importance it has attained. The balance is held fairly between capital and labour, and his opinions are frequently supported by quotations from representative authorities. But he has not succeeded in presenting a wide and comprehensive view of a great industry as a whole, with its many-sided and sometimes conflicting interests. We do not get a clear insight into the collective struggle that is arresting development and hindering progress on the one hand, nor on the other do we see the individual miner, who commands our sympathy by the important services he renders to the community and deserves our assistance in his fight, against adverse circumstances, to improve his social condition. Two causes have tended to blur the picture and distort the perspective. One is that the outlook, the statistics, and the conditions described, are practically limited to the pre-war period. This is ancient history, if not in point of time, by reason of the crowded events that have supervened, creating a new world with new purposes and ambitions, on which attention is now exclusively centred. For instance, we believe the term "nationalisation of mines" occurs only once in the book, and not at all in the index, and yet to write a book claiming to deal "with those aspects of the coal mining industry which are attracting so much public attention" and to make no mention of nationalisation is surely to leave Hamlet out of the play. The other is that the author has divided up his subject under so many heads, and discussed each separately, though not always exhaustively. By this method of treatment, the mutual bearing of the many influences at work on each other is not perceived. The superficial effects acquire undue prominence and the subtle latent causes in operation fail to get proper recognition.

Possibly no single work could deal adequately with so large a problem whose numerous branches penetrate the whole fabric of industrial life. Roughly, the author's survey may be regarded as covering three main issues in all of which the whole nation is vitally concerned, but unfortunately his examination does not proceed with progressive uniformity. There is first of all the labour problem, into which enter the methods of trade unionism and the antagonism between labour and capital; secondly, the employment of machinery in mines and the possibility of more economical working in the process of coal winning, and thirdly, the danger to which the miner's life is exposed and his social condition and environment. Such questions as the extent of the coal resources and the opportunities collieries offer for the investment of capital do not properly come within the limits of the work as defined by the title. All these questions are approached from the point of view of the colliery manager, who nurses a grievance against the Government for much legislation, that may have been admirable in intention, but which has proved unsuccessful in operation. The Minimum Wage Act, he regards apparently as an interference with the coal trade, as unwarrantable as it has proved disastrous, punishing the industrious and encouraging the indolent and inefficient worker. On the other hand, he recognises that miners require and deserve a fuller and freer life with a larger share of the available wealth. He sympathises with this laudable ambition, but he also perceives that the material advantages so keenly longed for are limited by economic conditions. This detached position should render his survey the more trustworthy.

In 1913, no less than 84 per cent. of the men employed in mining operations were members of trade unions, and in 1916, owing to an agreement with the Chief Industrial Commissioner, no workman might be employed in a colliery unless he were a

member of one or other of the recognised trade unions, the number has increased rapidly since. Probably the miners' unions boast a membership of not less than a million, and as these are led by their own class interests and governed by their own officers, they constitute an *imperium in imperio* that is not unfraught with danger to the entire community. And the author suggests, that this danger is aggravated by the fact that the Government is oligarchial, and its action determined by a few ardent and voluble members who may be moved by personal ambition or private and selfish motives. Lethargy and indifference characterise the attitude of the miners generally who place implicit confidence in the plausible delegates who control the whole machinery of the union. The mining lodges are seldom attended by more than the officials of the lodge, or those who are paid for attending. This indifference does not make the men less loyal to the decisions of their trusted leaders, and this unquestioned obedience too often makes the union an organ of mischief and an enemy of social order. It is to be feared that trade unions are responsible for many of the errors that circulate, and which tend to antagonise the mutual interests of capital and labour. In the effort to secure for manual workers better and fairer conditions of life, little attempt has been made to promote the skill or increase the efficiency of its members by insisting on intelligent and disciplined co-operation throughout the industry. The general impression which Mr. Bulman's account leaves is that trades unions have operated beneficially and that they have accomplished much, but that the full effect of the machinery has failed, owing to the insouciance of the rank and file and the want of a broad minded altruistic policy on the part of those who are responsible for the administration.

In the evidence before some of the recent Coal Commissions, witnesses representing labour have asserted, that if machinery, efficient in working and adequate in quantity, were employed in the mines the increased output would balance the proposed increase in wages, and that the price of the commodity could remain unchanged. As a colliery manager, the author is in a favourable position to discuss the extent to which machinery is replacing hand labour, and the economical advantages likely to follow its freer use. It is satisfactory to know that colliery owners are fully alive to possible improvement in this direction, and that machinery is being applied on an ever-increasing scale to every operation of coal mining, from the undercutting of the coal seam to the delivery of the coal at the weighing machines and screens. Similarly the work of cutting passages through hard rock is effected by the aid of power-driven drills. Mr. Bulman favours the introduction of more and more machinery, believing that increased output and high wages can be secured only by the greater employment of power. But he adds that the power must be "economically produced," and the value of this significant addition will be appreciated by those who have held responsible positions in the coal industry and know the sources and opportunities for waste. Very substantial sums are lost annually through inefficient machinery and unsatisfactory arrangements, and especially through the absence of intelligent oversight exercised without intermission over all steam losses. It might be expected, that where the means for steam raising are easily obtained little regard would be paid to undue waste, but that the coal used in steam production at the various collieries in Great Britain should amount on the average to 6·8 per cent. of the total output, is certainly startling, and this percentage will be larger as the machinery increases in amount. At 75 typical boiler plants, the average thermal efficiency was only 52 per cent., and the average amount of water evaporated per boiler, per hour, was only 437 gallons, whereas in similar boilers 30 ft. by 8 ft. 6 in., in other industries, 800 gallons per hour is the average quantity. Compressed air, so effectively used in connection with rock drilling machines, is another fruitful source of extravagance, mainly owing to the lack of exact measurement. Instances are quoted in which, through a defective joint in a main pipe, air was issuing wastefully at a rate equivalent to the value of 500*l.* per annum, a loss that would be prevented by the use of pressure gauges and air meters.

The use of electricity is to be recommended, among other reasons, because the power consumed is strictly measured, and faults are easily detected. A fair standard of efficiency is an essential condition in the operation of electricity. But apart from this consideration, collieries are particularly adapted for the generation of electric current on two grounds. The exhaust steam from the engines, and the gas from the coke ovens, can be utilised very advantageously in the steam turbine and in gas engines for electrical working. Central condensing plants have been adopted in some collieries, but the utilisation of low-pressure steam and of the mixed pressure steam turbine, has provided electricity in sufficient quantities, that much of this steam previously used is now saved. The saving has been put as high as 45 per cent. in comparison, with 25 per cent. to be got by condensing. The mixed-pressure turbo-generator is at present the most economical means of utilising exhaust steam. A further saving is effected by the establishment of central power stations, linked up with collieries, wherein the waste heat and coke-oven gases are turned to account. The power generated is greater than that required by the collieries, and is delivered into the mains of the power supplying companies for other purposes, permitting the "waste heat" stations to be run at their full capacity with a fairly even load. The saving of coal in the north-eastern area alone is said to amount to 150,000 tons per annum. The electricity is generated at a cost of 0·132*d.* per unit, of which 0·11*d.* is the cost of coal.

In face of such figures, and the author brings many individual cases to prove the pecuniary saving that follows the introduction of new types of machinery, colliery proprietors do not need any prompting from witnesses, however expert, to induce them to consider the question whether it will pay to scrap existing appliances and replace them by more modern and more economical plant. But they are confronted with another difficulty, that labour passes over with a very light heart. Organised labour has displayed no eagerness to embark on colliery enterprise, and has not been called upon to face capital expenditure. But to those who have to decide upon the policy to be pursued, the cost of providing mechanical power presents some difficulty. In a particular instance, however, the author shows that the substitution of a turbo-generator of the mixed pressure type for a battery of Lancashire boilers, might be economically effected.

The third main topic concerns the care of the miner's life and health, both in the mine and out of it. The chapter on rescue work is interesting, outlining the character and method of use of the more important devices designed to ensure greater safety in mining, and describing the steps that have been taken to educate and train miners to protect themselves from injury by the use of appropriate equipment. Reference might have been made to the Gibbs form of dress, used in America under direction of the Bureau of Mines. The Burrell gas detector also possesses some advantages which might have been mentioned. This form of detector not only dispenses with the use of the flame safety lamp, but enables the proportion of gas present to be determined within 0·1 per cent. In pursuit of greater safety, much has been done to minimise risks arising in the handling, transportation and firing of explosives, but the author seems to mistrust the value of many of the experiments that have been arranged to test the effects of explosion, and the character of the products of combustion. Certainly when a trustworthy explosive adapted to the conditions of a particular mine exists, it is better to adhere to its use. One may accept the verdict of the late Professor V. Lewes, that "the only true test of the safety of mining explosives is the practical one of use in coal mines over many years, and when an explosive has been in use on a large scale for over twenty years, without a single accident being traceable to its legitimate use, such an explosive holds a certificate of safety, that no series of tests under empirical and artificial conditions could ever give it."

The author has devoted very considerable space to the consideration of the housing problem. The examples of town planning and the schemes for the construction of cottages are not without interest. But the cottage of a miner does not differ greatly from that of any other artizan. The general differences are not striking, but there is one very agreeable feature to be noted, the spirit exhibited by many firms to give to their operatives improved social conditions. The author is quite justified in saying, that the miners' representatives at the Coal Commission created a very unfair prejudice against colliery owners by blaming them for the bad housing of the miners. In rebutting the evidence of the labour witnesses, Mr. Bulman mentions that the employers, in which may be included the shareholders of limited liability companies, have spent during the ten years, 1904–14, in Durham and Northumberland alone, more than 2,500,000*l.* in purchasing, building, and improving miners' houses. The war has prevented, or delayed, much of the good work that was being done, and it is regrettable that the whole of the facts could not have been put before the Commission.

BOOKS RECEIVED.

The Metric Fallacy. An Investigation of the Claims made for the Metric System and especially of the Claim that its Adoption is Necessary in the Interest of Export Trade. By FREDERICK A. HALSEY. Second edition, re-written. London: McGraw-Hill Publishing Company, Limited. [Price 12*s.* 6*d.* net.]

Walzenkalibrierungen. By J. DEHEZ. Düsseldorf: Verlag Stahleisen. [Price 36*s.*]

Problems in Physical Chemistry. With Practical Applications. By EDMUND B. R. PRIDEAUX, M.A., D.Sc., F.I.C. Second edition, revised. London: Constable and Co., Limited. [Price 18*s.* net.]

Department of Commerce. Bureau of Foreign and Domestic Commerce. Monthly Summary of Foreign Commerce of the United States. October and November, 1919. Washington: Government Printing Office. [Price 10 cents each.]

United States Bureau of Labour Statistics. Bulletins: No. 251. *Preventable Death in Cotton Manufacturing Industry.* By ARTHUR REED PERRY, M.D. [Price 30 cents.] No. 259. *Union Scale of Wages and Hours of Labour, May* 15, 1918. [Price 25 cents.] No. 260. *Wages and Hours of Labour in the Boot and Shoe Industry,* 1907 *to* 1918. No. 262. *Wages and Hours of Labour in Cotton Goods Manufacturing and Finishing,* 1918. [Price 10 cents.] No. 264. *Proceedings of the Fifth Annual Meeting of the International Association of Industrial Accident Boards and Commissions, Madison, Wis., September* 24 *to* 27, 1918. [Price 15 cents.] Washington: Government Printing Office.

United States Bureau of Mines. Ninth Annual Report by the Director of the Bureau of Mines to the Secretary of the Interior. June 30, 1919. [Price 15 cents.] Washington: Government Printing Office.

United States Geological Survey. Fortieth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, June 30, 1919. Bulletin No. 700. *The Analysis of Silicate and Carbonate Rocks.* By W. F. HILLEBRAND. I: 10. *Platinum and Allied Metals in* 1918. By JAMES M. HILL. II: 14. *Fluorspar and Cryolite in* 1918. By ERNEST F. BURCHARD. II: 16. *Sulphur and Pyrites in* 1918. By PHILIP S. SMITH. II: 17. *Silica in* 1918. By FRANK J. KATZ. Water Supply Paper No. 458. *Surface Water Supply of the United States,* 1917. Part VIII. *Western Gulf of Mexico Basins.* Washington: Government Printing Office.

Eleventh Annual Report of the Hydro-Electric Commission of the Province of Ontario for the Year Ended October 31, 1918. Vols. I, II and III. Toronto: A. T. Wilgress.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry, Vol. IV, 1919. London: Society of Chemical Industry. [Price 12*s.* 6*d.*]

Ozone. By E. K. RIDEAL, M.B.E., M.A., Ph.D. London: Constable and Co., Limited. [Price 12*s.* net.]

Elements of Steam and Gas Power Engineering. By AUDREY A. POTTER and JAMES P. CALDERWOOD. First Edition. New York and London: McGraw-Hill Book Company, Inc. [Price 15*s.* net.]

Armature Winding. A Practical Handbook for Students, Armature Winders and Engineers-in-Charge. By C. SYLVESTER, A.M.I.E.E., A.M.I.Mech.E. London: S. Rentell and Co., Limited. [Price 7*s.* 6*d.* net.]

Minutes of Proceedings of the Engineering Association of New South Wales. Vol. XXXIII. Edited by J. MCNAMARA. Sydney: Published by the Association.

United States Bureau of Mines. Bulletin No. 78. *Approved Explosion-Proof Coal Cutting Equipment.* By L. C. ILSLEY and E. J. GLEIM. [Price 25 cents.] No. 183. *Abstract of Current Decisions on Mines and Mining, Reported May–August,* 1919. By J. W. THOMPSON. [Price 30 cents.] Washington: Government Printing Office.

The "Electrician" Tables of Electricity Undertakings, 1920. London: Benn Brothers, Limited. [Price 10*s.* net.]

Elements of Radiotelegraphy. By ELLERY W. STONE. London: Crosby, Lockwood and Son. [Price 16*s.* 6*d.* net.]

DYNAMOMETER CAR FOR SWISS STATE RAILWAYS.

Fig. 1.

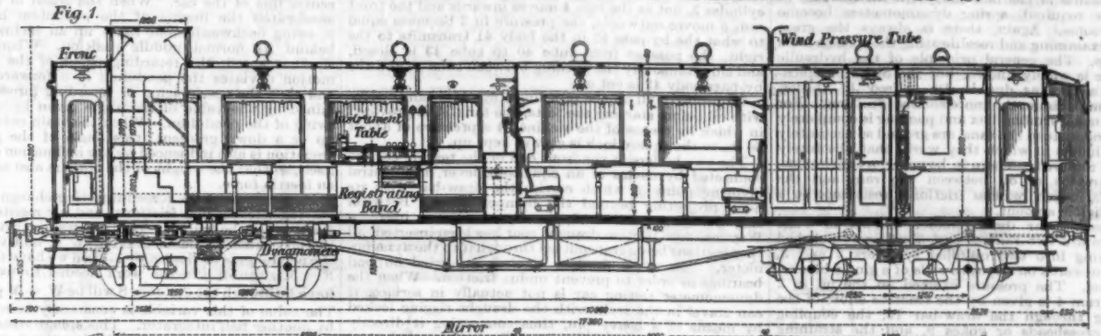
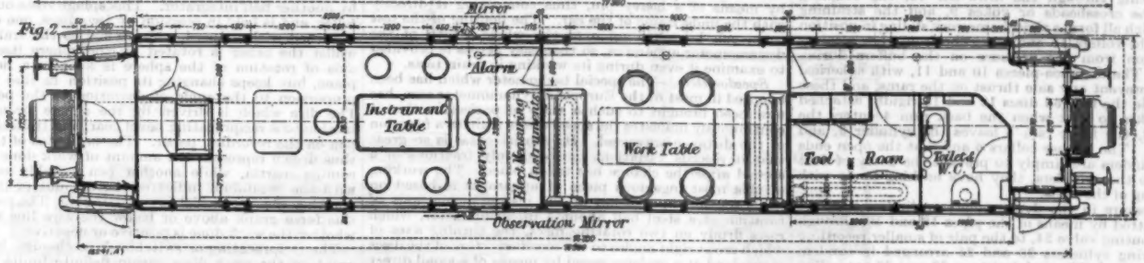


Fig. 2.



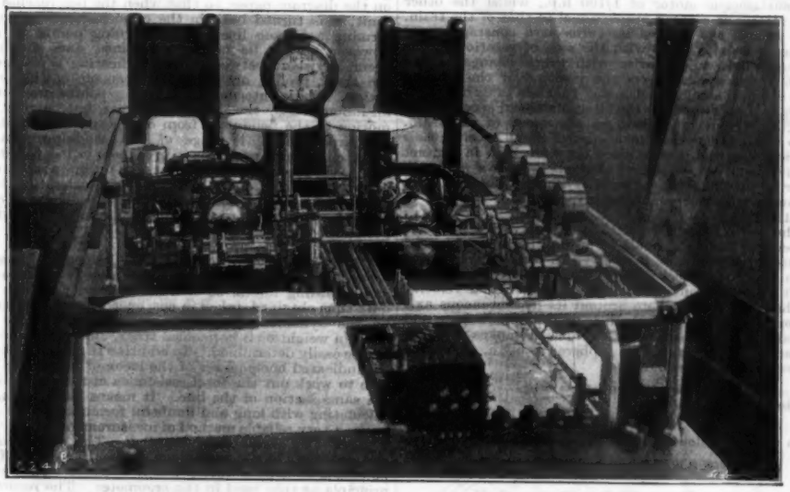


FIG. 3. INSTRUMENT TABLE FROM OBSERVER'S POSITION.

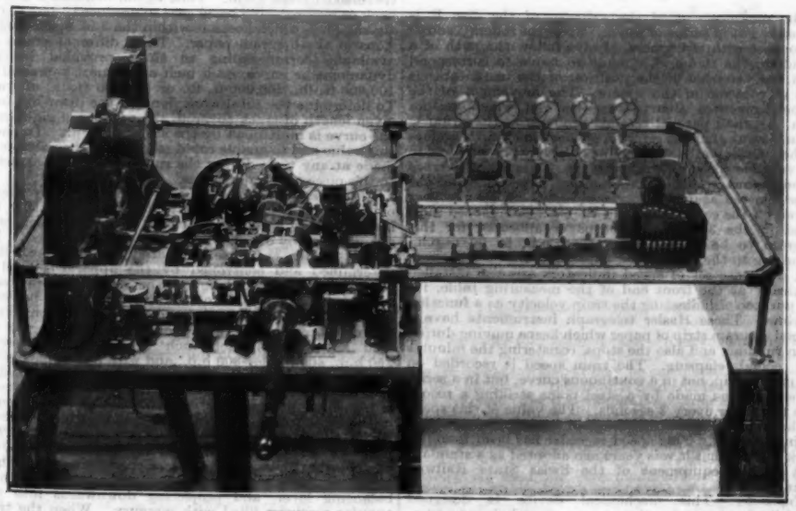


FIG. 4. INSTRUMENT TABLE FROM LEFT-HAND SIDE.

SWISS DYNAMOMETER CAR.*

By J. S. GLEN PRIMROSE, A.I.Mech.E., A.R.T.C.

THE designs of this car were prepared by the mechanical engineer of the Swiss State Railways, to whom the author is indebted not only for much of his information, but also for a very pleasant trip in the car about to be described. After a thorough study of all the principal questions involved in the selection of the type and general arrangement to be adopted as well as the measuring apparatus and the instruments required, the car was ordered from the Swiss Industrial Company of Neuhausen, and the equipment was put in the hands of a reliable firm of instrument makers which works under the direction of Dr. Alfred J. Amsler.

The completed dynamometer car which was first commissioned early in 1914, embodies a testing laboratory equipped with the most modern measuring apparatus and auxiliary recording instruments and devices as yet applied to a vehicle of this kind, whereby are met all the requirements demanded in the different running tests for determinating the efficiency of locomotives, the resistance of trucks or trains of various kinds, the power required for propelling trains on certain lines under different running conditions. To the end of 1919, the car has carried out tests over about 15,000 miles.

The car body (Figs. 1 and 2) rests on two four-wheeled bogie trucks of the railway's standard design. The underframe is made entirely of steel, and is of exceptionally strong design to meet all stress requirements. The side sills are arranged double in accordance with the extraordinary conditions met with in service. Outside of the usual truss rods under the side sills, there are vertical reinforcing armatures to ensure the whole frame against excessive collapsing stresses. The interior of the car is divided into four compartments. The first room, at the front or dynamometer end, is the test room, 21 ft. long, containing all the indicators and measuring apparatus. The instrmuent table is illustrated in the views Figs. 3 and 4. A cupola with an elevated seat just behind the front compartment affords a good view towards the engine looking into the cab, the signals, overhead wires and track ahead, as well as over the train behind. The second compartment, which serves as a workroom, is 13 ft. long, and then a short corridor leads to the back platform and gives access to a small tool-room having an outfit for making any running repairs, a work bench with chemical apparatus for doing exhaust gas analyses during the tests, and lockers for supplies. Adjoining this is a small lavatory, but no living accommodation is provided owing to the short main line service of the Swiss State Railways. The interior of fittings and finish are kept very simple. Electricity is used for lighting, and heating is done by steam from the engine. The Westinghouse automatic and non-automatic quick-action air brake acts on the wheels of three axles only; the rear axle of the front truck is left free from brake shoes as this is used for transmitting the motion of the train to the paper driving mechanism and other parts of the apparatus. The width of the car has been limited to 9 ft. 3 in., instead of the usual 10 ft., to permit mirrors being attached outside the car to give the observer a view of the track ahead from his position at the instrument table. The car measures 57 ft. overall in length, and when in full working order it weighs 82,000 lb., say 37 tons.

Hydraulic Dynamometer.—Although nearly all European dynamometer cars are equipped with spring

* Abstract of a paper read on January 16, before the Ipswich Engineering Society.

dynamometers, either plate or helical, it was decided by the builders to use the hydraulic principle in the Swiss car, because of the fact that with the increase in capacity now required, spring dynamometers become very cumbersome. Again, there is always the great difficulty of examining and recalibrating the springs from time to time. The general principle of the hydraulic dynamometer is widely known, but the Swiss modification of the apparatus due to Dr. Alfred J. Amsler, possesses some distinctly noteworthy features. For instance, the usual stuffing-box and packing is completely eliminated, and instead the rams are ground so accurately to fit the cylinders in which they work, that absolutely no packing is required. There is, however, a continuous, minute infiltration of oil between the ram and the cylinder walls, which reduces frictional resistance to a constant negligible amount.

In this testing car dynamometer, shown in Figs. 5 to 10, there are two rams 4 and 5, of finely-polished steel, projecting into two oil-filled cylinders 2 and 3, which open outwards on opposite ends of a single block 1 of forged steel. The pressure exerted on the oil in 2 by the back ram 4 is given by the tractive effort of the engine acting through the draw-bar 15, the coupling pin 14, the crossheads or yokes 9, and the straining rods 8, which all form a rigid framework sliding in position between the rollers 16 and 17. The front ram receives the reaction from the pressure on the buffers during braking. The distance-pieces 10 and 11, with spherical seatings, prevent any side thrust on the rams, and these work inside the flanged discs 12 and 13 rigidly attached to the yokes so that when the back ram 4 enters the cylinder 2, the front ram 5 leaves the cylinder 3, and *vice versa*. The leather collars 6 and 7 at the open ends of the cylinders are simply to prevent the entry of dust or air into the cylinders, they have nothing to do with the packing of the rams.

The pressure in the dynamometer cylinders 2 and 3 is transmitted by means of the pipes 18 and 19, through the distributing valve 24, to the pair of smaller recording or measuring cylinders 20 and 21 arranged in tandem with the pair of differential pistons 22 and 23 extending opposite to each other, the whole being arranged directly underneath the instrument table. The pressure in these cylinders acts on the two differential pistons 22 and 23, which permit the use of either of two areas, according to the setting of the distributing valve 24, so that the oil pressure in the oil spaces a and b may be either one-third or one-half of the whole pressure existing. Thus with a calibrated spring giving a maximum draw-bar pull indication of 60,000 lb., the distributor allows a change to be made to either 40,000 lb. or 20,000 lb. maximum pull without changing the spring.

A carefully-calibrated helical spring 26 is located between the two measuring pistons, and the amount of its compression is a measure of the load acting on the differential pistons. Then by knowing the ratio of the area of these pistons to the area of the dynamometer rams, the load on the draw-bar and also the buffer reaction can be accurately calculated from the indication of the recording pens. By simply turning the handle of the distributing valve, it is possible to select any one of three scales for measuring the pulling or buffer load, thus keeping the autographic diagrams for heavy trains within a reasonable space (4 in.) on the chart paper, without, on the other hand, sacrificing clearness in the diagrams for light train loads.

On the commencement of pulling, the pressure on the piston 22 moves the spring 26, by means of the cap 27, from right to left. This carries along with it the sliding casing 28, the connecting rod 29 and the recording pen 29A attached to the end of it. When buffer reaction is set up, the pressure on the piston 23 moves the spring 26 from left to right, carrying with it the cap 30, the sliding casing 31 and the rod with the recording pen 32. These two separate graph pens 29A and 32, attached in this way to the respective ends of the measuring spring, record the push-and pull continuously exerted, but since only one of them is working at any time, the same space is reserved on the chart paper for the ordinates of both.

In case small leakages of oil should occur in the cylinders of the dynamometer, say, for example, on the pulling side during a long continuous run, the two rams 4 and 5, which are rigidly connected with each other by means of the two longitudinal rods 8 and crossheads 9, would move away considerably from their central position in the cylinder block 1. It might even happen, after a very long period of pulling exertions, that the back ram 4 would come into contact with the end of the cylinder 2, thus making further measurements impossible. To completely avoid this possible defect, a reliable means of equalisation has been provided, which brings the rams 4 and 5 back to their original central position, immediately the slightest change from a pulling to a buffing action takes place. At this instant, an intercepting valve 41, with two check valves 37 and 38, produces a connection through a pipe line 40–46 between the two cylinders, thus equalising the pressure and permitting the rams 4 and 5 to return to their central position. The check valves close and the by-pass 42 between the cylinders is cut off as soon as the central position is reached.

As the back ram 4 moves inwards to the cylinder 2, causing therefore the front ram 5 to move outwards from the cylinder 3, oil is supplied to the chamber 3, which is increasing in volume from the oil reservoir 25 under atmospheric pressure. This oil passes through the tubes 43 and 40, and the valve 37, to the cylinder 3. Immediately the rams move forward, the pin 38 in the valve 37 moves the ball valve 39 off its seat to admit the oil to cylinder 3, whilst on the other side the check valve 36 prevents oil from escaping from chamber 2, and simultaneously the ball valve 45 is removed from its seating by the spring 44. On the top of the hydraulic cylinder 1 is a by-pass body 41 connected with the two check valves 36 and 37 and the oil reservoir 25. Inside the body is the by-pass 42, through which oil from the tube 43 can freely enter the body 41. Normally the oil from the reservoir 25 passes through the tubes 40 and 43 to the cylinder 3, but as the ram 4 moves inwards and the front ram 5 moves outwards, the pressure in 3 becomes equal to what the by-pass 42 in the body 41 transmits to the right, the passage from tube 40 to tube 43 is closed, and simultaneously the opening between tube 46 and the by-pass body 42 is cut off.

To properly fill all the pipe lines, cylinders and valves with oil before starting the tests, the tank 33 is provided in which by means of the air line 34 a pressure of about 50 lb. to the square inch is always kept up.

The two buffers at the front end of the testing car are connected by means of an equalising lever, the central pivoting point of which carries the draw-bar with its hook projecting beyond the bumper beam. Between this pivoting point and the dynamometer itself, a Westinghouse friction draught gear has been inserted, all the reactions being transmitted through it to the dynamometer. The whole draught rigging is carried on ball bearings in order to prevent undue friction. When the dynamometer testing car is not actually in service, it can travel in the train with the draught rigging locked by means of a heavy pin, thus connecting it directly with the underframe of the car. The flooring of the test room can be taken up over the whole length of the dynamometer apparatus, so that easy access is provided to examine it even during its working in train tests.

Speedometers.—The special tachometer which has been adopted in most of the European dynamometer cars, has now been brought to such a state of perfection that it continuously indicates the speed of the train as a function of the distance traversed. Its sensitiveness is so great that it records variations in speed only fractions of a second after the change has taken place. The working of this most ingenious piece of apparatus is based on the variation in position of the instantaneous axis of rotation of a steel ball about 4 in. in diameter, which rests firmly on two rotating discs, the turning axes of which are at right angles to one another. One of the discs is revolved at a uniform speed by means of a small direct current electric motor of 1/100 h.p., whilst the other disc rotates at a speed proportional to that of the train. The axis of the disc which turns at a constant speed makes a definite angle with the axis of rotation of the sphere. This angle varies with every change in the train speed which affects the position of the turning axis of the sphere, in such a way that the tangent of this angle is proportional to the circumferential speed of the disc, this being dependent on the speed of the train. Two small rollers held in a curved frame receive their motion from the sphere, since they are kept in contact with it and are so placed that they always maintain their path along the equatorial line of the ball, and follow it with every change in position of the axis of rotation.

The disc A (Figs. 11 and 12) is driven with a constant velocity v_1 from the small 1/100 h.p. motor with speed regulator, and the disc B receives its variable velocity v_2 from the spur wheel gearing actuated by the flexible shaft from the front truck axle. If the angular velocity of the integrating sphere around its instantaneous axis is represented by w, the radius of the sphere by r and the angle which the axis of the disc A makes with the instantaneous axis of the sphere x by a, then the following equations hold true:

$$v_1 = w\,y, \text{ and } v_2 = w\,y_2.$$

Again:

$$r\,.\cos a = y, \text{ and } r\,.\sin a = y_2,$$

from which it follows that:

$$r\,.\cos a\,w = v, \text{ and } r\,.\sin a\,w = v_2$$

or

$$\frac{v_2}{v_1} = \frac{\sin a}{\cos a} = \tan a$$

and therefore:

$$v_2 = v_1 \tan a.$$

The measurement of the velocity of the disc B is therefore got in terms of tan a. Since the rollers C and D in contact with the sphere, always follow the path of a meridian, the frame E is made to move to correspond with the variation of the position of the instantaneous axis of rotation of the sphere. The movement of the frame E operates a curved, toothed rod, which engages with the small parallel teethed grooves in the drum G in such a way that the rotation of the drum, and therefore of the pointer on the speed dial, is directly proportional to the variable speed v_2. A recording pen is made to trace a continuous graph on the diagram paper showing the speed plotted against distance covered. A change gear driven off the car axle enables the maximum speed indicated in the 3 in. width of paper allocated for this diagram to be altered from 45 m.p.h. to 90 m.p.h., according to the train speed expected.

A duplicate set of speed indicators are also installed vertically at the front end of the measuring table, for the purpose of indicating the train velocity as a function of time. These Hasler telegraph instruments have a special diagram strip of paper which keeps moving during train running, and also the stops, registering the minutes and seconds elapsing. The train speed is recorded on the paper strip, not in a continuous curve, but in a series of perforations made by a steel point striking a record into the paper every 3 seconds. The value of this speed is the average speed of the train during the two preceding seconds. This speed recorder has been found to work so well that it was years ago adopted as a standard part of the equipment of the Swiss State Railway engines.

Ergometer.—This mechanical device is designed specially for measuring the amount of work done in overcoming the inertia forces due to the train mass, leaving out of account frictional and air resistance forces. The main part of this ergometer, or work-measurer, consists of a pendulum suspended below the instrument table and able to swing freely in a vertical plane parallel to the centre line of the car. When the speed of the train is accelerated the inertia of the pendulum mass makes it swing backwards, and takes up an inclined position behind its normal middle position. When the train slackens speed, the retarding effect of the slowing up motion deviates the pendulum in a forward direction, and thus the accelerating or retarding forces are determined by the value of the angle given by the varying swing of the pendulum. When the train enters upon an up or a down gradient, this angle of the pendulum's deviation is also influenced by the inclination of the track itself, so that the weight of the train is also accounted as an inertia force.

If we represent the force imparting change of speed to the train (exception frictional and air resistance) by F, the mass of the train by M, the distance traversed by S, the acceleration due to gravity by g, and the angle of the pendulum's deviation by a, then we have the equation $F = M\,g \tan a$, and the work needed to overcome the force F through the distance S will be $W = M\,g \int \tan a\,dX$ The value of this variable is constantly being computed by another ball integrator. This sphere rests on a small roller, and is held in position by two discs, one of which is turned with a speed proportional to the train speed, whilst the other is rotated by the sphere itself. The axis of rotation of the sphere is kept in a horizontal plane, but keeps changing its position in that plane in proportion to the angle of deviation of the pendulum. The disc which is driven by the sphere transmits its motion to a reciprocating bevel gear, and from there to a pen on the recording paper. The ordinates of the curve thus drawn represent the amount of work done in overcoming inertia, while another pen suitably connected with the pendulum indicates the amount of its swing, and thus the force which is operating it. The position of this force graph above or below the zero line indicates whether the work done is positive or negative.

The reciprocating or switchback mechanism keeps the graph of the work done within definite limits reserved on the diagram paper, so that when the pen reaches the limit, it is turned back in the opposite direction, thus forming a zig-zag line. These turning points do not, however, always lie on the limit lines, since they may occur anywhere between them, indicating a change in the track profile, or the commencement of the brake action. These intermediate turning points are not at all influenced by the switch-back gear, but only by the motion of the pendulum from one position to another. The transmitting leverage of the pendulum can be adjusted to three positions to give more or less sensitiveness to the recording pen, so that 1 in. ordinate represents either 600 lb., 1,200 lb. or 3,000 lb. accelerating force per ton of train. In measuring the work diagram, each inch of ordinate represents 20,000 ft.-lb. of work done per ton of train weight.

The device has proved itself to be most useful and quite satisfactory in running trials, since it gives an accurate measure of the work done due to accelerating and retarding forces, as well as to gravity. With the data thus obtained, taken in conjunction with that given by the dynamometer, the average resistance per ton of train weight on a horizontal track, and for any speed, can be easily determined. In addition to this, if we know the indicated horse-power of the locomotive, we are also able to work out the total resistance of the engine over the same section of the line. It means that instead of calculating with long and doubtful formulæ, we are able to use a very reliable method of measurement.

Work done in the Draw-bar Pull.—The measurement and recording of the work done at the draw-bar in foot-pounds is done by a device which operates on the same principle as that used in the ergometer. The recording pen traces a curve, of which the ordinates are proportional to the work done: $W = F\,S$, where F is the instantaneous value of the draw-bar pull, and S is the distance traversed by the train. This, again, includes a switch-back or reciprocating bevel gear to produce the curve in a zig-zag form which keeps it within the 3-in. space limitations of the diagram paper. Three different scales are available, corresponding to those provided for the dynamometer curve, each inch of ordinate representing 100,000 ft.-lb., 200,000 ft.-lb. or 300,000 ft.-lb. of work. To determine the total work done on the draw-bar for a given length of track covered, the number of zig-zags in the curve is multiplied by the scale constant. To check this value and to enable rapid readings of the value to be made at any time during the run, a counter is attached to this piece of the apparatus.

The Draw-bar Horse-Power.—Is measured by means of a similar instrument to that used for getting the instantaneous speed indication. The metal sphere is again driven by one disc moving at uniform speed. The second disc in this case is rotated at a speed which is determined and controlled by the apparatus used in recording the work done on the draw-bar previously mentioned. The value of the draw-bar horse-power is thus mechanically computed and recorded in a continuous curve to any one of three scales, corresponding to the load scale. Thus each inch of ordinate represents 250 h.p., 400 h.p. or 800 h.p., and with a suitable change gear the value of the ordinates can easily be doubled.

Wind Resistance.—The wide resistance to the train is measured by a simple device based on the principle of the Pitot tube. Two tubes are made to extend about 30 in. above the top of the car at the rear end. The upper ends of the tubes are bent at right angles, the front one pointing forward and the rear one backwards. These tubes communicate with two 8-in. cylinders carried on a balancing lever, and projecting downwards into two annular receivers filled with mercury. When the train moves forward, air enters the forward tube and produces an increase of pressure in the pipe line and receiver,

whereas in the other tube the air pressure is diminished. This disturbs the equilibrium of the balance, and the lever inclines to the side with the lowered pressure. This motion is transmitted by a small rod passing through the table, and acting upon a calibrated indicator spring, to which a recording pen is attached. This is quite a newly developed instrument, and it is expected that it will be possible to correlate the ordinates of the recording pen with values of the component of the wind pressure in front of the train. Experience with its working has shown that vibration and shocks do not affect the balancing lever, and that any movement of the indicator is only caused by difference of air pressure in the tubes.

Integrating Cylinder Indicators.—It is usually very difficult to measure the power developed in the cylinders of a steam locomotive on accounnt of the comparatively small number of indicator diagrams which can be taken during a running test with an ordinary indicator, and generally the average indicated horse-power can be calculated only very approximately. An important innovation has been designed and used on the Swiss State Railway dynamometer car, which renders possible the measurement and the registering of the work done in every cylinder cycle. This integrating indicator consists of an ordinary outside spring indicator, to the end of the piston rod of which is fastened a lever mechanism carrying the integrating roller, which is a small disc kept in contact with the paper drum by a spring. Any increase or decrease of the steam pressure in the locomotive cylinder results in a corresponding radial displacement of the disc at the end of the drum. The oscillation of the drum about its axis due to the reducing motion, causes a rotation of the disc which varies in amount with its change in distance from the drum centre and transmits the movement to a counting apparatus. The indicated horse-power over a given period is easily reckoned from the difference in the readings of the counter at the beginning and the end of the test period.

As it is difficult to read the values of the counters mounted directly on to the indicators, an attachment has been added to the device for transmitting all the values by electric contacts to a recording apparatus located in the car, similar to the one on the engine. This arrangement enables the indicated horse-power to be determined continuously over any distance of track under any condition of weather or light. Beside the receiver of the electric recorder four magnet pens are arranged to make the necessary marks on the diagram paper from which the horse-power developed may be calculated in the easy way just explained. Provision is made for four indicators of this type, so that the complete determination of the indicated horse-power can be made on each side of a four-cylinder balanced compound engine.

Brake Performance.—For the careful investigation of the brake performance, the usual Kapteyn apparatus so extensively used, has been modified and improved so as to admit of its inclusion on the recording table beside the other instruments. The radial and tangential forces resulting from the action of the brake shoes against the wheels are measured by means of three hydraulic cylinders interposed in the brake rigging (see diagram, Fig. 13). Two of these cylinders form a part of the hangers for the front brake shoes of the forward axle of the front bogie truck, and serve to measure the tangenial forces. The third cylinder for indicating the radial force is attached to the brake rigging at the centre of the brake beam. The hydraulic pressures set up during the action of the brake are transmitted by suitably connected pipes to the indicators with recording pens on the instrument table.

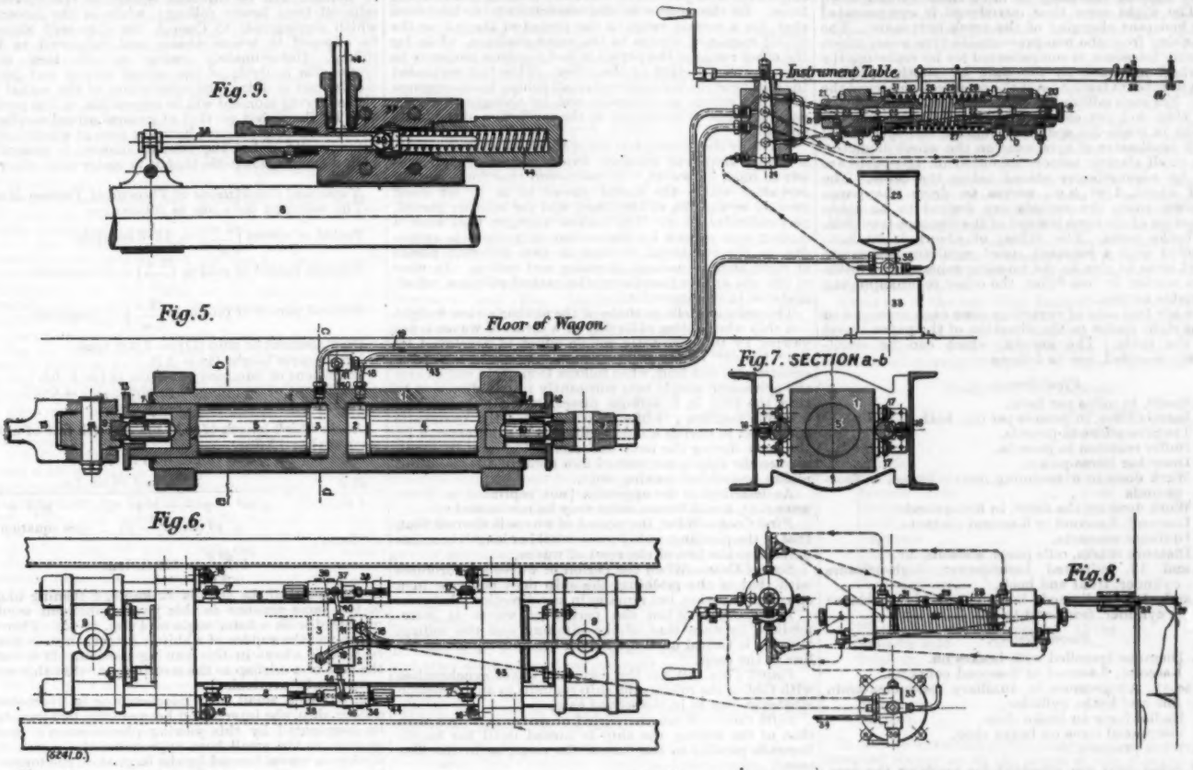
This arrangement can also be used for the determination of the coefficient of friction between the wheels and the brake shoes in order to test the material of which the shoes are made. Three other indicators are used for recording the pressure in the brake cylinder, in the train-pipe line, and in the auxiliary reservoir during each braking period. Provision is further made for an electric contact on the driver's valve in the engine cab to be connected with a special recording device, so that the duration and time of the stopping can easily be measured. The autographic pens of this recording apparatus can be put into working order at any time desired, or simply taken off so that they may be out of the way when tests are being made with the other instruments only.

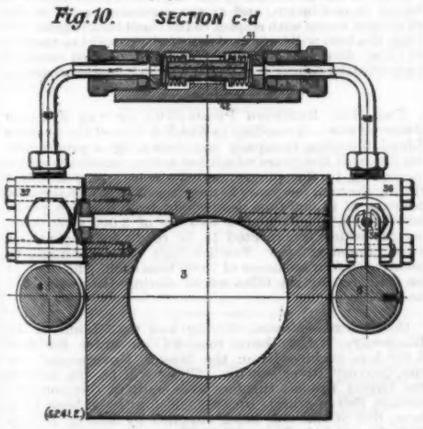
Instrument Table and Recording Pens.—All the apparatus are registering devices are mounted on a cast-iron measuring table, 69 in. by 35 in., securely fastened to the underframe-work of the car. The mechanical parts are well arranged, and all the more bulky instruments are located along with some of the mechanical gearing underneath the table; the wooden panels all around it can be removed and easy access obtained to the parts below. The instrument table is illustrated in the two views, Figs. 3 and 4.

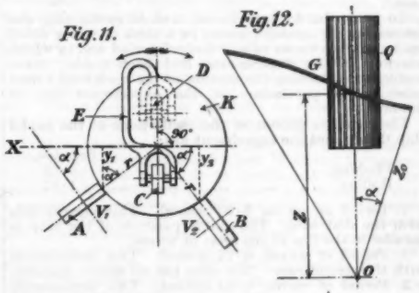
All the records are made on a continous chart of diagram paper carried on rolls of about 2 ft. wide. The paper passes across the table from one side to the other, and is then rolled up again beneath it. The travel of the paper can be altered by change gears to perform 1 in., 6 in. or 36 in. movement per car-mile, and an automatic reversing arrangement makes the paper travel always in the same direction whether the car is running forward or backward. To get a more distinct speed curve during brake tests the paper travel may be operated by motor drive to move 1 mm., 5 mm. or 30 mm. per second.

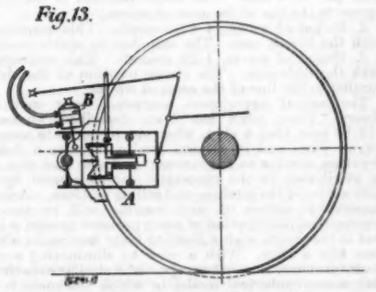
A box located at the right-hand edge of the diagram paper contains the magnets which operate seven electric pens, the first of which draws a line with offsets each minute, the second marks out either 1 second, 3 second or 6 second intervals, and the third is the distance recorder, marking out each mile of track traversed. A push button operated by the observer also causes this pen to mark an offset which can be marked to indicate an outstanding spot on the line, such as a station, a tunnel (on entering and leaving, a crossing), and so forth, which can be labelled to correspond with the track profile. The last four pens are reserved for recording the values communicated electrically from the integrating steam indicators.

The motion derived from the front truck rear axle which actuates all the parts of the measuring apparatus moving proportionately with the train speed, is transmitted from the axle to the main drive below the table by means of a cylindrical spur wheel gearing and a small









pinion connected to a flexible shaft. Since the actual amount of power thus transmitted is very small, and the resistance is reduced to a minimum by ball bearings, it was considered that the installation of a heavy worm gear drive could perfectly well be dispensed with. When no tests are being made, a small wire rope below the table enables the transmission gear pinion to be disconnected from the spur wheel, against which it is usually kept in contact by a spring.

The wheel tyres of the car are of standard tread, as it was not deemed necessary to have them turned down flat. The slight error thus introduced is compensated by the constant changing of the track curvature. The error arising from the non-preventable tyre wear, which constantly increases, is compensated for by replacing the spur wheel mounted on the axle by another with a smaller number of teeth to suit the smaller diameter of the wheel. For each millimetre of wear the error introduced is less than 0·1 per cent. for each mile travelled, but provision is made for spares to replace the spur wheel for each centimetre of tyre wear on the wheel diameter.

Two small electric motors mounted on the table are driven by accumulators placed below the table. The first of about 1/40 h.p., serves to drive the paper mechanism when the records are desired to be made as a function of the time instead of the distance travelled, as in brake tests. The other, of about 1/100 h.p., is provided with a constant speed regulator accurately adjusted so as to give to the rotating spheres a perfectly uniform motion by one roller, the other roller supplying the variable motion.

There are two sets of recording pens each arranged in a line at right angles to the direction of the paper travel across the table. The graphs, which can be simultaneously recorded, are as follows :—

First Group.

1. Speed, in miles per hour.
2. Inertia force, in pounds per ton, both + and −.
3. Tractive effort in pounds.
4. Buffer reaction in pounds.
5. Draw-bar horse-power.
6. Work done in overcoming inertia forces, in foot-pounds.
7. Work done on the draw, in foot-pounds.
8. 1-second, 3-second or 6-second contacts.
9. 1-minute contacts.
10. Distance marks, mile posts, stations, &c.
11 and 12. Indicated horse-power, high-pressure cylinder, front and back.
13 and 14. Indicated horse-power, low-pressure cylinder, front and back.

Second Group.

15. Distance travelled with brakes on.
16. 1-second, 3-second or 6-second contacts.
17 to 19. Air pressure in auxiliary reservoir—train line and brake cylinder.
20. Radial force on brake shoe.
21. Tangential force on brake shoe.
22. Wind pressure.

Eight other pens are provided for marking the zero lines for the curves drawn by the first set of pens, thus making 30 pens in all, which can be recording on the diagram paper.

Tests with Electric Locomotives.—In order to meet all the requirements for tests with electric locomotives now coming into greater use, a complete set of electric measuring and recording instruments has been installed in the car. This apparatus is mounted all together on a board on the back partition of the testing room, and includes the necessary voltmeter, ammeter, and two wattmeters, which make records with rectangular co-ordinates by a sparking device. The diagram paper in this apparatus is moved at the same speed as the chart on the main measuring table, so that easy comparison can be made of the two sets of data. All the electric wires and cables for connecting this apparatus with the engine motors enter the front end of the car through four specially-arranged intakes. The tables are fitted with brass plugs so as to make a tight joint and eliminate adverse weather conditions.

The latest type of passenger express locomotive, No. 12,201, was noted as capable of developing 2,500 h.p. by the use of four motors, each pair of which worked with terminal voltages of 500 transformed down from the 15,000 volts on the overhead wires. The double-ended engine comprised two bogies each of the three-coupled wheel type on each side, and end wheels, each driving axle possessing an adhesive weight of 20 tons. This load has necessitated the strengthening of many bridges by stiffening some steel ones and by replacing others with stonework. The cooling oil for the two transformer sets traverses 800 yards of pipe line outside the locomotive, which weighs 130 tons in all. Very perfect airtight connections are needed on the underframe to exclude the steel dust, about 40 tons of which is produced every year by the action of the brakes on some of the inclines.

YAWING OF SHIPS CAUSED BY OSCILLATION AMONGST WAVES.*

By Dr. K. Suyehiro, Member.

Although this phenomenon has not so far been studied by any investigators, it may perhaps have been noticed by seamen of keen observation, that a boat amongst waves sets itself parallel to wave crests in one case and perpendicular to them in the other case ; this being manifested most markedly when the boat rides on breaking rollers on a seashore. Even an ocean liner of the largest size, when she meets with huge waves, would be affected in a similar manner ; but this has escaped notice partly because huge waves are always associated with heavy wind, and partly because a ship, apart from this yawing, cannot in any case keep a straight course without constantly steering.

The first opportunity which occurred for the author to notice this phenomenon was during his experiments on the rolling of model ships ; in his experiments model ships were held parallel to waves by a small constraining force. In the course of the experiments it happened that, for a certain range in the period of the waves the model remained always in the same position, while for the other range of the period it had a strong tendency to yaw in one direction or the other. This fact reminded the author of the behaviour of small fishing boats amongst breaking rollers on a beach, and he thought that the yawing might be attributed to the oscillation of the boats on waves.

To study the general feature of such a motion on waves, a model ship was released from constraint and was left to itself on waves. It was found that for a certain period of waves the model yawed so as to set itself parallel to the line of the crest, and for another period, perpendicular to it. The author thought that such a motion was caused by the action of gyrostatic couple due to the rotational motion in two different planes at right angles—namely, pitching and rolling. In view of this the author found a mathematical solution, which is shown in the appendix.

This solution tells us that—if the author's view is right—a ship when riding obliquely to a series of waves is set yawing by the gyrostatic couple which is developed by the "forced" rolling and pitching. As can be seen from equation (4) and from what follows from it, in some cases the gyrostatic couple acts constantly in one direction to turn the ship in a definite direction until she reaches a stable position ; while in other cases the gyrostatic couple set in during a half oscillation is counteracted by the same during the next half oscillation, and in consequence the ship is not turned in a definite direction, but makes to-and-fro' yawing only.

As described in the appendix [not reprinted in Engineering], five different cases may be mentioned :—

First Case.—When the period of waves is shorter than that of the pitching, a ship yaws until her length becomes parallel to the line of the crest of waves.

Second Case.—When the period of waves synchronises with that of the pitching, the ship does not yaw in a constant direction, but remains in any direction whatever.

Third Case.—When the period of waves is intermediate between that of the pitching and the rolling, the ship is turned until her length becomes square to the line of the crest.

Fourth Case.—When the period of waves synchronises with that of the rolling, the ship remains in any direction whatever, just as in the second case.

Fifth Case.—When the period of waves is longer than that of the rolling, the ship is turned until her length becomes parallel to the line of the crest, as in the first case.

To prove this by experiment, a small model ship was set oscillating amongst waves in a tank of water fitted up to produce waves of any desired period and in which previous rolling experiments had been made. Cinematographs showing the motion of the model ship were taken. The particulars of the experiment are as follows :—

The complete periods of the oscillations of the model ship throughout the experiment are :

	Seconds.
Pitching	0·76
Rolling	1·17

1. Period of waves, 0·65 second. This corresponds with the first case. The stable position of the ship is parallel to the line of the crest of waves.
2. Period of waves, 0·75 second. This corresponds with the second case. The ship has no stable position.
3. Period of waves, 0·95 second. This corresponds with the third case. The stable position of the ship is square to the line of the crest of waves.
4. Period of waves, 1·17 seconds. This corresponds with the fourth case. The ship has no stable position.
5. Period of waves, 1·23 seconds. This corresponds with the fifth case. The stable position of the ship is parallel to the line of the crest of waves.

The actual experiment accorded very well with theory. From what has been described above, it will be seen that a ship, when set to oscillate amongst waves, yaws and in general finally assumes a definite direction relative to the waves ; and also that this may be attributed to the gyrostatic couple caused by the joint action of the pitching and rolling motions. Another conceivable source of such yawing will be the unsymmetrical distribution of wave pressure around a ship, that is inevitable with a floating body having an oblong form like a ship. With a view to eliminating such a doubtful source the author repeated a similar experiment with a semi-spherical model in which the mass is unsymmetrically distributed in order that it may represent a ship. It will hardly be necessary to say that with such a form symmetry of wave pressure can certainly be expected.

The period of oscillation of the semi-spherical model in water was as follows : The period of oscillation about an axis in the direction of the least moment of inertia, 0·83 second. The same about an axis in the direction of the largest moment of inertia, 1·13 seconds. It was found that the behaviour of this model amongst waves was similar to that of the ship-shaped model. Thus, the yawing motion of a ship under consideration may most probably be attributed to the gyrostatic couple due to the rolling and pitching motions.

Whatever be the cause of the yawing motion, the following facts which will naturally follow from this phenomenon, are especially worth mentioning.

1. When a ship rides on waves nearly synchronous to her period of rolling, two slightly different cases—namely, the period of waves a little shorter in one case and a little longer in the other case than the natural period of her rolling—which might seemingly bring forth the same effect on the rolling of the ship, will actually result in quite a different state of rolling. In the former case, which corresponds to Case 3, the ship, even if left to herself, will be directed square to the waves, and relieved from heavy rolling ; while in the latter case, which corresponds to Case 5, the ship will ultimately be exposed to waves abeam and subjected to heavy rolling. Unfortunately owing to the lack of the systematic analysis of the actual rolling and pitching oscillations of ships, the calculation of the actual value of the yawing moment will be impossible, as it is produced only by the forced portion of general mixed oscillations. Theoretical calculations, however (one of which is shown below), tell us that the yawing moment is generally of such a small magnitude that it is under easy control by a rudder.

Numerical Calculations of Theoretical Yawing Moment.—The assumed data are as follows :—

Period of waves $\left(\frac{2\pi}{p}\right) = 12 \cdot 5$ seconds.

Natural period of rolling $\left(\frac{2\pi}{\omega}\right) = 12$ seconds.

Natural period of pitching $\left(\frac{2\pi}{\omega'}\right) = 6$ seconds.

Displacement of ship (D) = 5,000 tons.
Metacentric height (h) = 2 ft.
Coefficient of damping of rolling (k) = 0·02.
Coefficient of damping of pitching (k') = 0·07.
Maximum wave slope (Φ) = 6 deg.

Angle which length of ship makes with line of crest of waves (α) = 45 deg.

Substituting these values into :

$$I\frac{d^2\theta}{dt^2} = \tfrac{1}{4} I_z \frac{\omega^2 \omega'^2 \Phi^2 \sin 2\alpha}{\sqrt{(\omega^2 - p^2)^2 + k^2 p^2}\ \sqrt{(\omega'^2 - p^2)^2 + k'^2 p^2}} \times p^2 \cos(\beta' - \beta) \quad \text{(see equation (4)}$$

we have :

$$I\frac{d^2\theta}{dt^2} = 356 \text{ ft.-tons}$$

If the speed of the ship is 12 knots, a turning moment of the same amount as this yawing moment would be produced with a helm angle of 4 deg. or so. Therefore, so long as the rudder of a ship is intact, there is nothing to trouble about in this yawing motion. It is only in the case of a mishap to the steering gear that this motion must not be overlooked.

2. When a small boat overtakes or is overtaken by a large ship, the interaction between the two vessels will be augmented by this yawing phenomenon ; because, as soon as the small boat approaches the region of the divergent waves formed by the large ship, the former will be set in oscillation, and as the apparent period of the divergent waves with respect to the small boat is generally long, the boat will be turned so as to lie parallel to the line of the divergent waves. Therefore, if not steered properly, the danger of collision will be increased thereby.

* Paper read before the Institution of Naval Architects, March 25, 1920. The paper was accompanied by some diagrams and a number of cinematograph figures which are too small to reproduce effectively in Engineering.

The New Building Programme of the Swedish Shipowners.—According to *Swedish Export* the Svenska Lloyd Shipping Company has drawn up a programme for the next few years which has a very extensive range. According to this programme the company will obtain during the next few years 25 new vessels with an aggregate tonnage of 91,000 tons deadweight from Swedish yards, and from a Dutch yard a steamer of 3,000 tons deadweight which is expected to be ready in a month or two. Amongst the Swedish-built vessels may be mentioned four steamers of 7,000 tons each, which are to be delivered by the Göta works during the years 1921 and 1922.

Contracts.—Messrs. Boving and Co., Limited, 56, Kingsway, W.C.2, have received an order for four 5,600-h.p. turbines from the Mysore Government, for the Cauvery River scheme. These will be, we believe, the largest Francis turbines ever built in this country, though Pelton wheels up to 8,000 h.p. have been built here, five of this size being supplied by Messrs. Boving and Co., Limited, to the Tasmanian Government. The turbines for Mysore are of the single-discharge spiral type for a head of 415 ft. and will run at 500 r.p.m. In addition, two Pelton wheels of 450 h.p. are required for driving the exciters. These new units form the first group of the large machines which are to replace the smaller machines now installed, in order to better utilise the power available.

Electric-Furnace Spectra of Metals.—With the aid of photographic emulsions stained with dicyanin, Arthur S. King, of the Mount Wilson Observatory (*Astrophysical Journal*, April, 1920), has succeeded in photographing the electric-furnace spectra of some metals in the infra-red, up to 9,200 A.U. He treated "Seed 23," or Eastman portrait films, with the dicyanin, both after the method of Merrill, and he made use of concave gratings and tubular vacuum furnaces. The metals studied were cobalt, nickel, barium, strontium, and calcium, and the furnace temperatures were approximately 2,400 deg. C., 2,100 deg. C. and 1,900 deg. C. Furnace spectra and arc spectra differ, and it was found that most of the arc lines of more than a certain minimum intensity were also observed in the furnace. Some strong arc lines were, however, absent in the furnace, whilst some faint arc lines appeared strong in the furnace.

THE SPECIFIC HEAT OF REFRACTORY MATERIALS.

*The Specific Heat of Refractory Materials at High Temperatures.** By L. BRADSHAW and W. EMERY.

VERY little in the way of experimental data relating to the heat capacity of refractories is available, and for calculations a value of about 0·2 is usually taken as a basis. Wilson, Holdcroft and Mellor gave 0·193 + 0·00006 *t* as the mean specific heat of fireclay between 0 deg. and 1,300 deg. C. Assuming an average value of 0·2, it would require about 66 lb. of coal (of 8,100 lb. calories calorific value) to raise a ton of firebricks to 1,200 deg. C., but as the average specific heat between 0 deg. and 1,200 deg. C., has been found to be 0·284, about 94 lb. of coal would really be needed, or 42 per cent. more than the first estimate. For the same weight of silica bricks (average specific heat 0·282 deg. C. to 1,200 deg. C.) and zirconia bricks (average specific heat 0·167), about 93 lb. and about 55 lb. of coal respectively would be required to heat to 1,200 deg. C.

The authors ascertained the numerical values of the specific heats at temperatures at which refractories are ordinarily employed, ranging from 600 deg. C. to 1,400 deg. C. For measuring the furnace temperature a thermocouple was used up to 1,100 deg. C., and beyond that point a Féry radiation pyrometer was employed. The temperature of the water in the calorimeter was ascertained by means of a Beckmann thermometer reading to 0·005 deg. C.

The mean values of the specific heats at 600 deg. C., 1,000 deg. C., 1,200 deg. C. and 1,400 deg. C. found in the case of Scottish firebricks were 0·228, 0·265, 0·284 and 0·297 respectively, and two types of silica bricks, with over 96 per cent. and over 84 per cent. silica respectively gave very nearly the same results, the greatest difference being only 0·004 less than for the firebricks. For pure zirconia (99 per cent.) the corresponding values were 0·137, 0·157, 0·167, 0·175. With all these materials a much greater amount of heat is required at high temperatures to raise the temperature of a given weight of refractory, through the same number of degrees. Thus, the average specific heat of the fire-brick between 100 deg. C. and 300 deg. C. is 0·201, and between 1,200 deg. C. and 1,400 deg. C. (the same interval) 0·290, so if 20 units of heat would raise a ton of firebrick from 100 deg. C. to 300 deg. C. 29 units would be required to raise an equal weight from 1,200 deg. C. to 1,400 deg. C. The fuel consumption at the upper temperature compared with that at the lower, other things being equal, would be nearly as 3 : 2.

The differences between the specific heats of silica bricks and fireclay bricks are small, as might be expected from the fact that at ordinary temperatures the values for silica and alumina are nearly the same. Taking the specific heats of Scottish and Stourbridge firebricks to be practically identical at 100 deg. C., and that Wilson and Holdcroft's value (0·194) at 100 deg. C. is correct, the mean specific heat of firebricks would be 0·193 + 0·000075 *t*, or an increase of about 25 per cent. more than their estimate. The results obtained by the authors agree closely with those obtained by Wilson and Holdcroft for Stourbridge firebricks up to 1,000 deg. C., but above this temperature the results obtained by the latter seem too low.

* Abstract of a paper read before the Ceramic Society at their Meeting at Stoke-on-Trent on November 10, last, and also read before the Institution of Gas Engineers, on Tuesday, June 1, 1920.

CATALOGUES.

Telephones.—Loud-speaking marine telephones made by Messrs. Siemens Brothers and Co., Limited, at their Woolwich works, are illustrated and described in a special catalogue recently issued by the firm.

Oil Separator.—A separator described in a catalogue from the Griscom-Russell Company, 90, West-street, New York, U.S.A., separates the oil and also the volatile oil gas from exhaust steam.

Pneumatic Tools.—Particulars of a complete range of pneumatic tools for workshop, yard, and underwater work are given in a special catalogue from the Consolidated Pneumatic Tool Company, Limited, 170, Piccadilly, London, W. 1, and Fraserburgh, Scotland.

Reflectors for Industrial Lighting.—The British Thomson Houston Company, Limited, 77, Upper Thames-street, London, E.C. 4, send a very useful and interesting catalogue of metal reflectors for industrial lighting.

Steam Tables.—A copy of the fifth edition, dated 1920, of the little handbook of steam tables for condenser work, issued by the Wheeler Condenser and Engineering Company, Carteret, N.J., U.S.A., has come to hand.

Stern Tube Appliances.—The construction of the well-known appliances made by the B. R. Vickers (Leeds) Engineering Company, Limited, Leeds, for protecting and lubricating propeller tail shafts is illustrated and clearly described in a new edition of their catalogue.

First-Aid Cabinets.—First-aid cabinets and the appliances necessary for the immediate treatment of accidents in the works are shown in a small catalogue from the Surgical Manufacturing Company, Limited, 85, Mortimer-street, London, W. 1.

Electric Welding.—A catalogue giving a brief description of electric welding processes and illustrating a number of machines made for special work, comes from the Pontelec Welding Patents, Limited, 46, Constitution Hill, Birmingham.

Anti-Rust Paint.—A brilliant black enamel for protecting iron work from rust due to water, salt, or acid fumes, is described in a catalogue issued by the manufacturers, Messrs. Robert Bowran and Co., Limited, 4, St. Nicholas Buildings, Newcastle-on-Tyne.

Small Craft.—A very attractive book of illustrations of yachts, schooners, launches, cruisers, boats, &c., has been published by the Parsons Motor Company, Limited, Southampton, to show examples of the craft in which their small marine engines have been fitted. A few particulars of power and speed are also included.

Metal Sawing Machines.—A good variety of sizes and forms of sawing machines for metal is shown in the catalogue of Messrs. Edward G. Herbert, Limited, Levenshulme, Manchester, and particulars are also given of clamps, angle plates, box jigs, adjustable packing blocks, and similar accessories for the machine shop.

Marine Oil Engines.—A handbook explaining the Bolnes marine oil engines comes from the British agent, Mr. Arthur R. Brown, 54, New Broad-street, London, E.C. 2. These engines are of the two-cycle type, made in Holland in sets ranging from 10 h.p. to 600 h.p., and they are suitable for small craft and cargo boats. The construction is very clearly explained in the handbook.

Marine Oil Engines.—Messrs. Perman and Co., Limited, 82, Fenchurch-street, London, E.C. 3, send a catalogue of the Kromhout marine oil engines which are made for British and Colonial trade by Messrs. Day, Summers and Co., Limited, Southampton. These engines are designed for barges, tugs and coasting craft, and as auxiliary power for sailing vessels.

Anti-Corrosion Paints.—A small pamphlet received from Messrs. Gammon and Smith, of Petersfield, Hants., gives particulars of tests made to demonstrate the anti-corrosive and heat-resisting properties of their "Everlasting" paints for iron and steel. Lead paint for patterns and anti-corrosion enamels made by the firm, are also referred to.

Steam Engines.—A very comprehensive series of traction engines, and portable, semi-portable, undertype and other stationary steam engines is shown in a catalogue from Messrs. Ransomes, Sims and Jefferies, Limited, Ipswich, together with a number of independent vertical and other boilers, and hauling, winding, pumping and sawing machinery suitable for agricultural or contracting work. A separate price list issued gives particulars of the main plant and also of all usual accessories and fittings.

Steel Handbook.—A handbook and catalogue of about 200 pages, strongly bound, which has been issued by Messrs. H. G. Skelton and Co., Limited, Finsbury-square, London, E.C. 2, gives dimensions, weights, &c., of iron and steel sections, various standard specifications, and a large amount of technical data of use to structural engineers. It is printed throughout in English and French, on opposite pages, and is obtainable from the firm at the price of 7*s.* 6*d.* net.

Electric Tools.—A catalogue from the Consolidated Pneumatic Tool Company, Limited, Fraserburgh, N.B., and 170, Piccadilly, London, W. 1, deals especially with portable electric tools; mainly drills, spike drivers, grinders, coal and ore borers, blowers, &c. There are also several examples of gear for applying the tools in special places; for instance, between tram or other rails, inside boiler furnaces, on the tool posts of lathes, &c. The information is carefully compiled so that a suitable tool can be selected for any given work.

Voltage Regulator.—An automatic voltage regulator, made by the Metropolitan Vickers Electrical Company, Limited, of Manchester, is an instrument suitable, for example, for controlling the pressure in a station having a number of generators of different outputs, where each generator has its own exciter and all exciter voltages and characteristics vary. Additional new generating machinery can also be controlled by adding relay coils with their contacts, &c. All the various parts are very clearly described with the aid of an excellent illustration of the complete mechanism.

The Michell Viscometer.—We have received from Michell Bearings, Limited, 3, Central Buildings, Westminster, a capitally-got-up pamphlet describing the Michell viscometer. This instrument consists of a ball and cup into which the ball fits. A little of the liquid of which the viscosity is to be measured is placed in the cup and the ball pressed home. The time taken for the ball to drop free after inverting the instrument is directly proportional to the absolute viscosity of the oil. The apparatus is thus direct reading, and reliable determinations can, it is claimed, be made with unexampled rapidity. The pamphlet describes in full detail the best methods of using the instrument, according as to whether merely rough approximate values are required or highly accurate figures. Even in the latter case over 30 determinations can, it is stated, be made in an hour.

Roller Bearings.—Roller bearings for shafting and truck axles are described in a preliminary catalogue received from the Empire Roller Bearings Company, Limited, 13, Victoria-street, Westminster, London, S.W 1, working in association with Messrs. Ransomes and Rapier, Limited, of Ipswich. The rollers are solid and are separated by caging, but the shafting type is made in halves, so that it can be applied to any part of a shaft without removing pulleys or couplings. The bearings are intended to be applied to the shaft without employing a special sleeve. The height from base of bearing to centre of shaft is 3 in. for a 1¼ in. diameter size and 5 in. for a 3 in. diameter size—which brings them reasonably near to the outside dimensions of ordinary brass bearings. Eight standard sizes are listed for shafts ranging from 1¼ in. diameter to 3½ in. in diameter. The axle-box and truck-wheel types have continuous ring cages.

THE UTILISATION OF TITANIFEROUS IRON ORE IN NEW ZEALAND.*

By J. A. HESKETT, New Plymouth, N.Z.

NEW ZEALAND is wholly dependent on the outside world for all its iron, although it possesses at least two well-defined iron ore deposits.

At various times small companies have sought for short periods to develop these deposits, one at Para Para [a limonite ($3Fe_2O_3 + 2H_2O$), also found as lower hydrated oxides], and the Taranaki iron-stand, a combined magnetite and ilmenite ($2FeO + 2Fe_2O_3 + FeO + TiO_2$).

The former is of massive variety, and the latter granular and mixed with various proportions of fine shell and siliceous sand well water-worn. This latter deposit forms the greater portion of the beach sands of the west coast of North Island. Its fineness can be gauged by the fact that a sample passed entirely through a sieve of 40 meshes to the inch. The ilmenite cannot be detected by the microscope as it can in the titaniferous ores of the Adirondacks, nor can it be magnetically separated. To all appearances it is a definite double oxide of iron and titanium and not a mechanical mixture of the two, as in the Adirondack deposit and the titaniferous deposits of the Natashkwan Province of Quebec, where a very nearly complete separation can be made by magnetic separation.

Analyses of the two New Zealand ores are given, one from the published result of the Government Laboratory analysis of Para Para ore, and the latter the standard works analysis of the New Zealand Iron Ore Smelting and Manufacturing Company, at New Plymouth.

Analysis of Ore Deposits.

	Para Para.	Iron-Sand (Taranaki).
	Per Cent.	Per Cent.
Silica	9·56	2·20
Alumina	3·36	3·31
Ferric oxide	71·25	44·36
Ferrous oxide	1·94	33·91
Manganous oxide	0·65	0·64
Lime	0·51	2·16
Magnesia	0·10	2·83
Titanium dioxide	0·63	9·31
Phosphoric anhydride ...	0·35	0·59
Carbon dioxide	0·10	—
Alkalies	0·08	undetermined
Water and loss on ignition	11·84	—
Vanadic acid	—	0·28
Sulphuric anhydride ...	0·21	0·05
Iron	51·38	57·30
Phosphorus	0·15	0·25
Sulphur	0·08	0·02

It may be advisable at this stage to advance a generally accepted theory as to the origin of the deposits on the coasts of New Zealand. They originated from one or more upheavals, at sea, of molten oxides which when in contact with the water immediately granulated It is a known fact that it would require a high temperature and an abundant supply of water to give such fine granulation as is evidenced in this unique deposit. Both in this case would be forthcoming. The fact that throughout the soils of the interior a few grains can be collected, some far removed from the sea front, can be explained by their having been wind-blown, like the shell-rock deposits which abound at various parts. This theory is in keeping with the author's investigations.

The composition of the iron-sand will vary according to the locality, no two samples ever being identical although at various points of the coast, where the concentrating action of the heavy sea has thrown up, and so concentrated, the blue-black oxide, the analysis is fairly constant. When, with calm seas, only the lighter siliceous material is washed up and the subsequent winds blow with force, the lighter and darker sands are soon mixed and so build the sand dunes which are very common on these foreshores, leaving the deposit very patchy. These dunes contain anything from 20 per cent. to 40 per cent. of iron.

The deposits, although readily accessible at various points, are by no means inexhaustible in the European or American sense, although they would go far to supply the demands of New Zealand. There is no doubt that at certain points of the coast there are places where the concentration is everlastingly throwing up iron oxide. Whether it would form a sufficient source of supply is a debatable point.

The analysis of the iron-sand shows it to be very similar in composition to mill scale; practically all the gangue is free, excepting a little white silica, which can be detected under the microscope, attached to the blue-black oxide. This forms, however, only a small percentage of the gangue. The author has, with a hand-magnet, concentrated down to 98·6 per cent. metallic oxides. It is suggested that it is the high ferrous oxide content of this ore that gives it its magnetic properties and unless properly taken into account has the detrimental effect of retarding reduction in the blast furnace, with the result that uncarburised metal reaches the hearth and so diffuses amongst the metal. This has been proved over and over again in all the attempts at smelting the iron-sands. It is often stated that the iron produced from iron-sand is sluggish and cannot be tapped from the furnace, or that only high carbon steel can be made from iron-sand, and that grey iron cannot be produced. These statements are based on experiments whereby only the same time for reduction of a soft

* Paper read before the Iron and Steel Institute, on May 6.

hematite or limonite similar to Para Para was allowed for iron-sand. This has been the ruination of practically all attempts to utilise the iron-sands of New Zealand.

The author accepts the theory that, usually speaking, an iron ore low in ferrous oxide and high in ferric oxide is a more readily reducible ore than *vice versa*. Hence a premium is paid on these easily reducible ores. The iron-sand requires a greater percentage of direct reduction than is common on the easier reducing ores. The detrimental effect is shown by the following equations :—

$Fe_2O_3 + 3CO = 2Fe + 3CO_2$. Thermal value + 426 B.T.U. per pound of carbon.

The above is known as indirect reduction, or Gruner's ideal in the working of the blast-furnace, where the CO does the greater portion of reduction.

It is natural to expect that an iron ore that will not yield up its oxygen to CO readily and depends on fixed carbon for reduction must give rise to a high $CO : CO_2$ ratio in the escaping gases and miss the more favourable circumstances for indirect reduction. Knowing the difficulty with which the iron-sand is reduced, and after giving due consideration to the circumstances, the author conceived the idea that if the reduction were made largely a direct one it would be more complete and the gases would be richer in CO, thus attaining the desired result. With this in wind, a process of mixing also as plant to grind the two materials finer was not available, resource was had to a very weak solution of sodium silicate to assist bondage, briquetting and coking. The briquettes were charged in the experimental furnace of cupola design, as described, along with coke and limestone, and smelted. The result was the absence of any "fines" whatsoever and free running slags ; but the iron was white, mottled, and low in silicon, namely, 0·4 per cent., also more carbon was used per ton of iron produced than in the previous process, and the daily production was a little less.

Fig. 1.

Fig. 2.

e, e, Tap-hole x, x, x, Titaniferous Material

angle 70 deg., and a bell and hopper, hand operated. The blast (with a pressure of 20 oz.) was raised to 1,000 deg. F., and the bosh was water-spray cooled, and both tuyeres and coolers were water-cooled. The binding power of the coal in an eight of sand to one of coal mixture was raised by fine grinding the sand and coal together to an impalpable powder in a Fuller-Lehigh mill. It was then briquetted in an ovoid briquette machine and carbonised. The resultant briquette contained 50 per cent. of iron. The furnace was blown in on this trial, and the first tap (about 1 ton) was an 8 per cent. silicon iron (ferro-silicon). As this burden was only 15 ft. above the tuyeres it showed that the direct portion of reduction was satisfactorily doing its work. The second tap (3 tons) was 2·5 per cent. silicon, and it subsequently averaged 1·6 per cent. silicon until the blow-out. The coke consumption was very high, averaging 35 cwt. per ton of pig-iron produced in the early stages, which later increased to excessive amounts in the form of blank charges to surmount obstructions in the hearth just below tuyeres. These obstructions eventually proved to be titaniferous accretions which were accumulating and gradually raising the bottom until it reached high enough to prevent tapping. Instead of mitigating the titanium deposits, forcing the heat had the contrary effect, and contributed in no small measure to the closure to this trial much earlier than it

FIG. 3. VIEW OF WORKS SHOWING IRONSAND DEPOSIT, ALSO WHARF AND BREAKWATER IN THE DISTANCE.

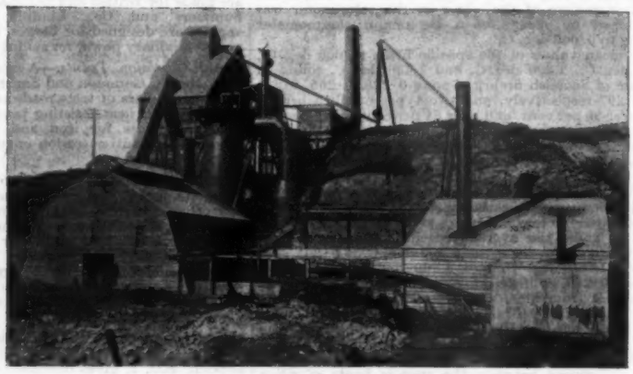


FIG. 4. VIEW OF FURNACE AND PLANT.

coking coal and fine iron-sand in equal proportions and coking, was evolved. The resultant coke or ferro-coke contained 36 per cent. metallic iron and 40 per cent. carbon, and at the same time a greater portion of the oxide was reduced to a metallic state in the 8 hours which elapsed in the coking process. This ferro-coke was charged along with the limestone into the experimental furnace (a furnace somewhat resembling a foundry cupola, 8 ft. from charging door to tuyeres and 3 ft. in diameter served with four tuyeres with a 6-oz. blast pressure, water-jacketed, and provided with water-cooled tuyeres). As soon as the ferro-coke reached the tuyeres (which was about an hour after charging) the rise in temperature as between ordinary coke and ferro-coke was very pronounced, owing to a small proportion of the metallic iron in the ferro-coke oxidising and thus giving an exothermic reaction. This small amount of oxidised iron was deoxidised in the descent from tuyere to hearth. At the tuyeres little globules of metal and slag could be seen sweating out of the ferro-coke compound and coalescing to form big beads of metal, and dropping to the bottom to collect, ready for tapping. This looked like an ideal process, giving a good iron under cold-blast practice, and producing 10 tons per day of very close-grained grey iron of the following composition :—

	Per Cent.
Graphitic carbon	2·82
Combined carbon	0·75
Silicon	0·91
Manganese	0·42
Phosphorus	0·56
Sulphur	0·04
Titanium	0·28

After repeated experiments this process was, however, abandoned, the unexpected trouble being due to the friable nature of the ferro-coke at incandescent temperature, causing a mass of finely-divided coke to become entrapped in slag and gradually settle in and contract the working area of the hearth.

The technical explanation of the cause of the disintegration at high temperature was the formation of amorphous carbon (plainly visible if a piece of ferro-coke were withdrawn by tongs from the furnace through the tuyeres, allowed to cool and broken), similar to lamp-black, and to the carbon deposition in an iron ore in the tops of any ordinary blast furnace under certain conditions.

What the result of hot blast instead of cold blast on the "fines" from the ferro-coke would have been is a matter of conjecture only. The method of reduction (a direct one evolved in the coking process) was highly satisfactory. The idea of keeping as close to the above principle of reduction as possible, yet modifying it to obviate the disintegration troubles, led to a process of mixing one part of coal with three parts of sand, and as this mixture was a little short of binding properties, and

Any difference in the quality and quantity of iron produced from the combinations of these different processes in the same furnace and under the same condition was due to the preparatory treatment the compounds received. No. 1 compound (one of coal to one of sand mixture) was coked in a retort, and the time taken was 8 hours, which was sufficient to reduce the bulk of the iron oxides to a metallic state, and, in a greater measure, the material nearer to the edges of the retort than that at the middle of the charged retort. The resulting compound is simply finely divided, deoxidised, semi-carburised iron mixed with coke ; and in smelting this small portion of iron content it decarburises and oxidises at the tuyeres, giving a higher temperature in the hearth, akin to hot blast, and yielding higher silicon iron, which accounts for the grey fracture. The No. 2 compound (three of sand to one of coal) had no doubt sufficient carbon to deoxidise the ore, but the short space of time in carburising this compound, namely, 30 minutes, was not sufficient time to deoxidise the ore—in fact, this was to be avoided, as the compound would disintegrate unless cintering were resorted to. Hence this compound was charged into the short furnace, and such reduction as took place was direct, a few feet above the tuyeres, with a lower yield of iron of low silicon content and a somewhat higher coke consumption (approximately 27 cwt. to the ton of iron). The better process commercially was that with No. 1 compound if disintegration could have been avoided.

The results of compounding with sand and coal gave an impetus to the idea of cintering the iron-sand, and as the reduction in smelting would be indirect the furnace height was raised to 51 ft. and charging effected by an inclined skip-way. The cinter was broken down to 1 in. mesh and charged as usual with ore and coke practice. The iron produced was steely uncarburised iron with a scouring slag, clearly proving the results of the two previous methods to be consistent. The idea of cintering this refractory magnetite and ilmenite was thereupon abandoned.

A stage had been reached where the indifferent quality of iron produced by cold-blast practice on the compounds, as described, necessitated expert advice to warrant the expenditure which was anticipated as required to bring the process to perfection. Mr. Aubel, a metallurgical engineer, then engaged in Australia, was invited to visit, report and advise, and on his recommendation a hot stove was installed and the height of the existing furnace increased.

Eventually the U-pipe hot blast was installed, and the process was brought more in keeping with ore reduction in modern practice, relying upon a greater percentage of indirect reduction yet involving a direct one if required, when a mixture of eight parts of sand to one part of coal was used.

The furnace used was 45 ft. high, with a vertical height of 8-ft. bosh ; a 4-ft. diameter hearth ; bosh would otherwise have been. The amount of pig-iron produced was 50 tons (averaging 5 tons per day). The following is an average analysis of the iron produced :—

	Analysis of Iron. Per Cent.
Graphitic carbon	2·89
Combined carbon	0·70
Silicon	1·60
Manganese	0·45
Sulphur	0·06
Phosphorus	0·51
Titanium	0·63

	Average Slag Analysis. Per Cent.
SiO_2	30·7
Al_2O_3	17·6
MnO	0·5
FeO	1·0
CaO	31·2
MgO	4·1
K_2O, Na_2O	2·6
TiO_2	10·2
S	1·2
V	undetermined

The slags were very fluid, and no trouble was experienced in handling them. The titanic acid content would lead one to believe that it had lowered the fusion-point as well as the viscosity of the slag. At times the titanic acid content was brought up to 20 per cent. in an experiment on subsequent trials, and the fluidity was in no way impaired, so the theory of viscid slags due to abnormally high titanic acid content might very easily be disproved.

The accretion which built up in the hearth was of a greyish colour and filled the spaces between the coke in the hearth, leaving a solid mixture of coke and ferro-titanium with cinder entrapped. The ferro-titanium was magnetic, and when struck with a hammer showed the well-defined metallic appearance. The stony fracture was caused by the non-metallic cinder being incorporated in and around the metallic portion.

The analysis of the combined cinder and metallic ferro-titanium was as follows :—

	Per Cent.
Fe	46·5
Ti	16·5
FeO	0·4
MnO	0·2
SiO_2	11·6
Al_2O_3	6·1
CaO	11·1

NgO	1·6
TiO_2	3·8
S	undetermined
P	,,
V	,,
Alkalies	,,
	97·8

Another sample was crushed very fine (as fine as the metallic portion would allow), and separated over and over again by a hand-magnet under water into metallic and non-metallic particles, with the following results :—

	Magnetic. Per Cent.
Fe	66·5
Ti...	26·1
Si	3·7
S	0·1
P	0·4
Mn	0·5
C	2·1
V	0·5
	Non-Magnetic. Per Cent.
SiO_2	17·9
Al_2O_3	20·1
TiO_2	39·3
CaO	12·5
MgO	6·1
S	0·8
Alkalies	undetermined
V	,,
MnO	,,
FeO	,,

An interesting sidelight on this titaniferous deposition was thrown on examining a sample of the slag which flowed through the tap-hole after casting iron. This slag, which was allowed to settle in a sand well arranged for it, showed when cooled a clear line of demarcation between a top and bottom layer of different coloured slags, and on examination showed metallic material settled at the bottom and intimately mixed with cinder.

The analysis of the top and bottom layers were as follows :—

	Top. Per Cent.
SiO_2	33·3
Al_2O_3	15·6
MnO	0·5
TiO_2	9·9
CaO	34·6
MgO	2·1
FeO	0·2
S	1·4
Alkalies	2·1
V	undetermined
	99·7
	Bottom. Per Cent.
SiO_2	26·1
Al_2O_3	21·4
MnO	undetermined
TiO	13·7
CaO	23·5
MgO	0·9
FeO	0·2
S	1·3
Alaklies	undetermined
V	,,
Fe	11·3
	98·9

The top layer was of a sky-bluish tint, with a stony fracture, crystalline at the heart, and with a somewhat vitreous appearance at the edge. After weathering it showed no sign of rust. Under the microscope the same portion showed a massive formation with here and there a few crystalline formations, but no sign of metallic particles. The bottom layer had a dark bluish tint, with a metallic material spangled throughout. It was dense on the bottom of layer, but less so as a line of demarcation was reached. Here and there in this metallic portion a coppery-coloured deposit was perceptible. The bottom layer had a higher specific gravity than the top layer, viz., 3·8 to 3·2, and this sample if allowed to weather showed a rust formation on the bottom layer, the top remaining unaltered. Under the microscope this bottom layer showed a matted mixture of metallic material and crystalline slag of quartz-like appearance with a violet tint. The metallic portion was partially globular and of graphitic appearance, interwoven with slag.

The iron thus entrapped in this slag was a direct loss, and to see whether it was at all fusible the top and bottom layers were melted in a small clay assay crucible (about 2 in. diameter). The top layer melted rapidly and was fluid at approximately 2,600 deg., but the bottom layer became pasty only at 3,000 deg. F., never flowed at all, and came out of the crucible like a ball of dough. This ball was hammered with a wooden mallet, and flattened out like a piece of iron to about ¼ in. thick and 6 in. in diameter. It required a sharp blow to break it. On another occasion a tap of slag was allowed to settle in the slag ladle, and as a little iron had come over (about 50 lb.), this showed a conical-shaped button of iron and then a layer of ferro-titanium in a matrix of slag. This material when tested withstood fusion at 3,000 deg. F.

From the foregoing results the idea was conceived that it would be possible, by tapping at short intervals, to tap both slag and iron through the tap hole, the assumption being that the material in the hearth, just on tapping time, was as shown in Fig. 1. The iron in the hearth was assumed to be about a 12-in. layer, titaniferous material 2 in. and slag 2 ft. Naturally as the iron flowed out of the tap hole the titaniferous material would follow and be flushed with the slag following as long as there was plenty of such slag. The diagram (Fig. 1) shows a sandwiched material of pasty character, which will not flow from the furnace unless it is flushed as an inert material in a fluid slag. This method of flushing was adopted at a later trial after the hearth had built up 2 ft. above the original tap hole, and the furnace was tapped regularly every 2 hours, and finally the hearth was reduced at tap hole side to the original tap-hole, but the back side of the hearth was built up as shown in Fig. 2. It might be imagined possible to tap on either side of furnace alternately and thus keep both sides clear, but this was never tried.

From the above experience the author estimated that approximately 85 per cent. of the TiO_2 content of the iron ore was accounted for as a constituent in solution in the slag. The balance, viz., 15 per cent., was made up of approximately 5 per cent. of a high TiO_2 cinder and 10 per cent. of ferro-titanium. The explanation of the figures is that the TiO_2 content of the ore is approximately 10 per cent., and the balance of the gangue will total approximately 10 per cent. If no other slag-making material were added to furnace burden and the ash of coke be assumed to be nil, a very refractory slag would result, almost infusible and containing approximately 50 per cent. TiO_2. The author's contention is that the gangue in the ore on the iron being liberated in the bosh of the furnace is composed of approximately 50 per cent. TiO_2, 11 per cent. SiO_2, 16 per cent. Al_2O_3, 10 per cent. CaO, and 13 per cent. MgO. This would form an infusible slag in blast-furnace practice, and this refractory cinder, unless it coalesced with the CaO from the limestone of the burden during descent to hearth, will reach the hearth, where it is doubtful whether the bath of slag will absorb it totally, as being of higher specific gravity it will sink to iron level of the molten material in the hearth. The amount that will come to the hearth uncombined with CaO during descent is problematical. Again, if it came unmixed with lime in proper proportions, how much of the high TiO_2 cinder would combine with the molten bath of slag in the hearth in passing from the top of the bath to the bottom is conjectural; but there is one point certain, and that is, that when the iron and slag are tapped and the furnace hearth is "dry," the chances of the high TiO_2 cinder reaching the hearth are great, and although the amount may be small, say, 0·1 per cent., this amount will only require time before it produces a crisis.

The following analysis of a sample of cinder from the hearth corroborates the foregoing :—

	Per Cent.
TiO_2	52·1
SiO_2	9·5
Al_2O_3	15·6
CaO	13·3
MgO	7·3
S.	1·1

This sample when heated in a clay crucible to 3,000 deg. F. was mushy, but when ground and intimately mixed with limestone in proper proportions and heated to the same temperature was very fluid. This sample was almost free of metallic material and was hard and brittle, with a dark grey stony fracture, and was taken from between two pieces of coke which had become entrapped. It is worthy of note that although the accretions are high in TiO_2, no two samples would give identical chemical results and would vary from between 40 per cent. and 50 per cent., due no doubt to the amount of slag the high TiO_2 cinder generally takes up in transit to hearth from the ash of the coke. This, by the way, was very low, approximately 1 per cent. The mushy TiO_2 cinder generally had entrapped metallic titaniferous material and at times graphitic iron almost free from titanium, although this varied considerably.

The author now assumes that if the high titaniferous ore were composed of sufficient gangue to make a self-fluxing burden the hearth troubles would be at an end. In the case of iron-sand the lime could be intimately mixed and either cintered or briquetted to give a self-fluxing ore. Under these conditions the gangue, once free from the iron, could journey to the hearth as a very fluid slag, with no chance of depositing TiO_2, as the TiO_2 in solution will not precipitate out. This process is the subject of patent, and it will be interesting to watch the result of a trial which is about to be undertaken. Any metallic material, such as ferro-titanium compounds, would no doubt result from what took place before the tuyeres, where the high temperature is sufficient to reduce by direct reduction a portion of the TiO_2 and to alloy with iron and carbon. This alloy will no doubt be absorbed in the bath of iron up to saturation point, and any excess, if not flushed away in slag, might be readily absorbed by iron intermittently charged from a burden of non-titaniferous ore. The author is convinced that TiO_2 will form up to 20 per cent. of a slag, as proved in practice, and that this slag is as fusible as any blast-furnace slag. He has watched the slag flow from the cinder notch and observed scintillations of what he imagined was iron, oxidising. On investigating he found practically no FeO in the slags, or not enough to lead to the large amount of scintillation which takes place, hence he believes it to be due to metallic titanium in suspension in slag, and oxidising.

There is no doubt that the flushing of both slag and iron through the tap hole at short intervals will overcome the titaniferous accretions, but this method is uneconomical on the score of the loss of iron involved. It is quite possible that the alloy (ferro-titanium, which is very easily reclaimed, especially where granulation is resorted to) could be used in steel manufacture as additions, when required, and if the carbon content be not too high. This would make this method a commercial as well as a scientific success. Even where granulation was not resorted to, the flushed slag could be crushed and the magnetic portion recovered by passing the crushed material over a magnetic separator. Under the circumstances a very satisfactory method would be to mix an ore of non-titaniferous content in proportions best adapted to absorb the precipitated titanium-bearing alloy. The amount of absorption would vary according to the hearth temperature. Practice seems to give 0·6 per cent. of Ti as an average point at which absorption ceases.

If his contention as to the amount of TiO_2 in solution in slag as against the metallic Ti produced be correct, 50 per cent. of a non-titaniferous ore and 50 per cent. of titaniferous ore of approximately 10 per cent. TiO_2 content, mixed, will make a good and successful mixture to handle the accompanying titanium.

This theory has verified itself in practice at Port Henry, U.S.A., where Mr. Bachman reports satisfactory results from mixing non-titaniferous and titaniferous ores. Whether the practice of mixing the two ores is a benefit to foundry practice or not remains to be seen. The author's experience is that the pig-iron produced from titaniferous ore will not grain out like other iron of similar analysis. It has a ready tendency to chill even in ordinary sand casting, with silicon 2·5 per cent. and sulphur 0·04 per cent. This chill is only to a depth of $\frac{1}{16}$nd of an inch on the above analysis. The iron is exceptionally strong and tough, easily standing 25 per cent. greater breaking strain and deflection, as shown on a standard testing machine. Castings made from this iron have a wonderful finish, surpassed by no other iron used in the author's foundry experience. When extreme softness is required in thin castings there are founders who object to this iron. Personally, he believes it to be more adapted to steel production than everyday foundry work. For steel it is eminently suitable, and steel which has been produced from this iron has exceptional strength, ductility and malleability.

MACHINE-MADE AND HAND-MADE SILICA BRICKS.

*Tests of Machine-made and Hand-made Silica Bricks.**

By W. EMERY and L. BRADSHAW.

Early attempts at making silica bricks by machinery were unsuccessful mainly because of employment of unsuitable machines and failure to recognise the importance of correct proportioning and tempering of the materials. The marked inferiority of the bricks produced created prejudice which still seems to exist. The authors submitted two batches of silica bricks, made from the same materials under identical conditions except the actual moulding, to laboratory tests, and the results distinctly favoured the machine-moulded bricks. The bricks were prepared from crushed Dinas silica rock bonded with lime, using the ordinary hand process and the Stanley brick machine respectively. They were all dried together and fired in the same kiln together at 1,380 deg. C. The spalling tests and abrasion tests were comparative, but other tests were standards.

Little or no difference was observed between hand-made and machine-made bricks as regards refractoriness (softening point cone 33), refractoriness under load (collapsed at cone 26 under 50 lb. per sq. in.), reversible expansion or temporary increase at 1,200 deg. C. (1·2 per cent. increase in length), after-expansion or permanent increase in size when subsequently heated at 1,350 deg. C. (0·355 per cent. for machine-made, and 0·360 per cent. for hand-made), and porosity (25·0 and 25·1 per cent. respectively). The apparent specific gravities were 1·85 and 1·80 respectively.

Tests for crushing strength, spalling, and resistance to abrasion showed notable divergences between machine-made and hand-made bricks. The average crushing strength (cold) was 2,270 lb. and 1,630 lb. per sq. in.; spalling tests showed respectively 36 per cent. and 56 per cent. loss in weight, or alternatively (by different tests) 8·5 per cent. and 35·5 per cent. loss in crushing strength; resistance to abrasion (by sand-blast) showed a loss in weight of 106 grams and 143 grams respectively. Since crushing resistance and spalling are largely influenced by the porosity, the practical identity of the porosities enables a closer comparison to be made between the two classes of bricks.

The tests for crushing strength, spalling, and abrasion were designed to expose internal weakness due to lamination, cracks, and want of uniformity, and the machine-made bricks appear to advantage in these important particulars. The superiority of the shape and close jointing of the machine-made bricks was evident from the appearance of two groups of representative bricks arranged in two blocks placed side by side. This was further shown by 18 measurements of each dimension of three bricks of each class; the machine-made bricks showed no differences in width and not more than two hundredths of an inch in length, whereas hand-made bricks showed an extreme difference of eight hundredths of an inch both in width and length. The two batches of bricks are to be tested in actual service. As the authors point out, the question of shape is also applicable to firebricks.

* Abstract of a paper read before the Ceramic Society at their meeting at Stoke-on-Trent on November 10, last, and also read before the Institution of Gas Engineers, on Tuesday, June 1, 1920.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

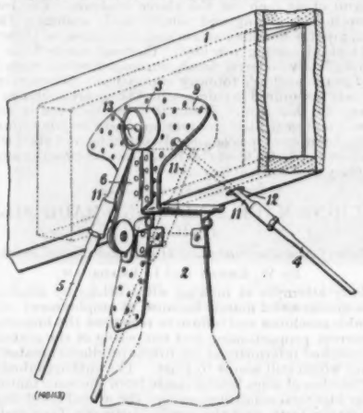
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

140,113. F. Handley Page, London. Framework of Aircraft. (2 *Figs.*) April 20, 1918.—The invention relates to improvements in adjustment devices for the tension wires of the structural framework of aircraft of the type in which ten ion wires are secured to a pin or spindle in a line intercepting the neutral load axis of a spar or strut pierced to receive it. According to the invention a tubular bush is adapted to extend transversely through a neutral axis of a spar, and has apertures in its walls to receive the tension members. A spar 1 has a strut 2 connected with it by a suitable attachment device. The spar 1 is perforated transversely to receive a tubular bush 3 extending through the neutral axis of the spar. Through the walls of the tubular bush 3 holes are formed to receive the ends of the tensioning devices 11 of bracing wires 4 and 5, which pass through the walls of the



tubular bush 3 radially and are secured in position by segmental stiffening elements 13 located within the interior of the tube 3. These stiffening elements 13 are screw-threaded to receive the ends of the said tensioning devices. By this construction the forces acting on each of the bracing wires 4 and 5 will meet in the neutral axis of the spar. On each side of the spar 1, where the tube 3 projects, plates 9 having strengthening ribs 6 are arranged. The projecting ends of the tube 3 are perforated to receive the tensioning elements 11 of the bracing wires 5 which pierce the tube radially. The said bracing wires 5 pierce the tubular bush 3 at right angles to the bracing wire 4, which latter pierces the wall of the tubular bush 3 midway of its length, a hole 12 being arranged through the spar 1 for the passage of the said wire 4. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

140,156. J. Pulford, Manchester. Tool-holder. (8 *Figs.*) January 24, 1919.—The invention relates to tool holders of the kind in which a round steel tool is firmly gripped around its entire circumference and along its entire length practically to the cutting edge, in a rectangular bar which is bored longitudinally to accommodate the tool, one side of the bar being split in a horizontal plane passing through the axis of the boring so that

Fig. 1.

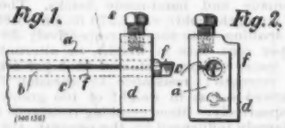
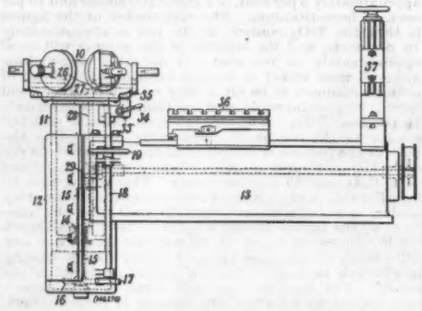


Fig. 2.

the split bar can be clamped firmly round the tool along its entire length. A straight bar *a* of mild steel of an oblong shape in cross-section is bored longitudinally at *b*, the axis of the boring lying centrally of the short side of the bar, but to one side of the long side of the same; the bar in practice resting upon the short side remote from the boring *b*. The latter is preferably larger at one end than the other to accommodate tools of different diameter. A parting *e* is made in the bar at one side parallel to one of the short sides and in the plane of the axis of the boring, said parting extending from end to end of the bar and from the exterior to the boring. Clamping means are provided to compress the bar around the tool when the latter is in position comprising a rectangular collar *d* adapted to fit either end of the bar and provided with a pinching screw *e* arranged to one side of one of the shorter ends, and so as to lie directly over the parting *e* in the bar *a*, on the top side. The tool *f* projects from the end of the holder *a*, and the clamping collar *d* can be positioned along the length of the bar so as to constitute a stop or gauge when using the tool for internal boring or like purposes, or if desired the clamp may be retained at the end of the bar and the tool caused to project to the desired extent to govern the depth of the boring. (*Accepted March* 31, 1920.)

140,270. T. Lumsden, Gateshead. Horizontal Boring Machine. (2 *Figs.*) May 22, 1919.—The invention relates to horizontal boring machines, and has for its object to provide a machine capable of performing any one of a number of operations, for example, boring, drilling, reaming, snout-boring, facing, face-milling. The invention consists of the combination with a horizontal boring machine provided with a horizontal work-carrying table which is longitudinally and transversely adjustable, of a horizontal rotary turret mounted on a vertically-adjustable column and provided with a plurality of rotary tools and means for selectively driving any one of said tools, said column being disposed in a bearing at one end of the bed of the machine. 10 is a horizontal rotary turret carried by a vertical column 11 capable of vertical adjustment in a bearing 12 at one end of the bed 13 of the machine. The column 11 is of square section, and is provided with a nut 14 through which passes a screwed shaft 15 geared by toothed wheels 16, 17, to a shaft 18 having fixed on it a hand wheel 19, by which it can be rotated. Rotation of the



hand wheel 19 is communicated to the screwed shaft 15, which co-acts with the nut 14 to raise and lower the turret 10. The turret 10 is hexagonal in plan and is provided with six rotary tools. The drive for the tools is arranged so that any one of them is put into gear with it when the turret is horizontally rotated to bring the desired tool into position for use. Each tool-holder is provided with a bevel wheel 26, adapted, when brought into proper position, to engage a bevel pinion 27 on a vertical shaft 28 driven through bevel gearing 29, 30, by a horizontal shaft 31 in the bed of the machine provided with a belt-driven pulley. The bevel 29 is keyed to the shaft 28, which has a long keyway, so that it can slide through the bevel as the column 11 and turret 10 are adjusted vertically. A spring plunger 33 operated by a hand lever 34 is adapted to engage one of a series of recesses 35 in the underside of the turret to lock the latter in any one of its six positions. The work to be operated on is mounted on a horizontal work-table 36 which is capable of longitudinal and transverse motion to bring the work up and feed it to the tool. 37 is a stay or support for one end of the boring bar. (*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

140,238. D. M. Cunningham, Armadale, Linlithgow, and Stein and Atkinson, Limited, Westminster, London. Furnaces. (4 *Figs.*) April 23, 1919.—This invention has relation to furnaces employed in the heat treatment such as

Fig. 1.

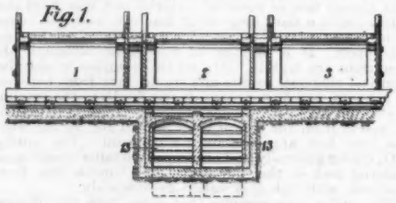
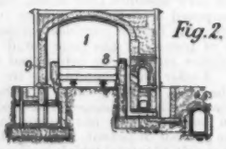
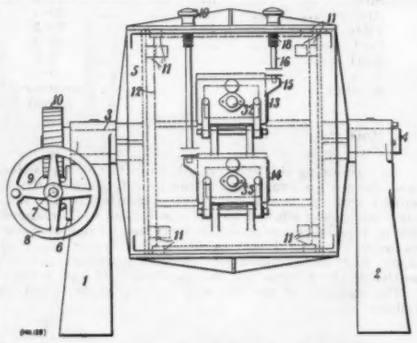


Fig. 2.



annealing, of metals and metallic bodies. In accordance with this invention, a furnace comprises the combination with a plurality of separately-heated chambers 2, 3, having doors or closures at each end, one chamber 2 forming a treating chamber proper (hereinafter referred to as an annealing chamber), and another 3 a cooling chamber, said chambers being independent the one of the other or others, and arranged in line for the purpose of enabling the metallic bodies to be subjected to heat treatment, to be treated in one chamber independently of the treatment of those in the other chamber or chambers, and to be moved directly from chamber 2 into chamber 3 in sequence and in a straight line, of a gas and/or air recuperator 13 heated by waste products from the annealing chamber 2 and of the kind in which the gas and/or air flow or flows vertically, and the waste products flow horizontally, and ducts or channels 9, 8, connecting the gas and/or air inlets and the waste product outlets of the annealing chamber 2 with the recuperator 13. Further, in accordance with this invention, a preliminary or heating-up chamber 1 having doors or closures at each end is also provided, and is in line with and independent of the annealing chamber 2 for the purpose of enabling the metallic body after heat treatment in one chamber to be moved directly, and in a straight line from the heating up chamber 1 to the annealing chamber 2, and from the annealing chamber 2 to the cooling chamber 3, in sequence. (*Sealed.*)

140,138. A. Imbery, Halifax. Electric Muffle Furnace. (1 *Fig.*) June 4, 1919.—An electric muffle furnace constructed according to the invention, having a plurality of muffles and the furnace chamber mounted in such manner that it can be tilted, has a plurality of doors for said chamber which can be separately opened by the withdrawal of spring catches, on such tilting reaching the desired angle, whereby the contents of any muffle or all the muffles can be dropped by gravity directly into cooling bath. On standards 1 and 2, is mounted on trunnions 3 and 4, the shell or casing 5 of the furnace. On the standard 1 is a bracket or bearing 6, in which is a spindle 7 rotated by means of a hand wheel 8. On the spindle 7 is a worm 9 in mesh with a worm wheel 10 secured on the end of the trunnion 3. The shell 5



is built up of metal plates having inwardly-projecting lugs 11 in contact with the moulded firebrick body 12. On the front of the shell 5 are two hinged doors 13 and 14, on each of which is a lug 15 having a recess as shown in dotted lines. A spring latch 16 normally registers in the recess in the door 13, but can be withdrawn by means of a milled handle 17 compressing the spring 18 and releasing the door. A similar spring latch 19 is applied to the door 14. When the articles treated have been heated to the required temperatures, the hand wheel 8 is actuated to tilt the furnace in a forward direction, the bolts 16 and 19 are then withdrawn, when the articles under treatment will fall by gravity into a quenching bath, placed between the standards 1 and 2. (*Sealed.*)

STEAM ENGINES, PRODUCERS, HOLDERS, &c.

140,162. C. Turnbull, North Shields. Boilers. (2 *Figs.*) February 5, 1919.—The invention relates to means for improving the circulation of water in boilers. According to the invention, downcomer tubes are so disposed in the boiler, and their lower ends are so formed that the nascent steam bubbles will be swept off the external surfaces of the furnaces by the rush of the downcoming water issuing from the lower end of the downcomer tubes. This arrangement has, also, the advantage that the solid matter dissolved in the water is not deposited at those parts as a hard scale from particles of water individually insulated by an envelope

Fig. 1.

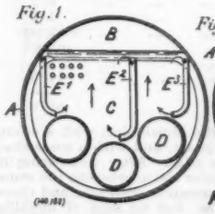
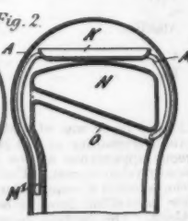


Fig. 2.



of steam, but is carried away by the stream of water. A represents the boiler shell, B the steam space, C the water space and D the furnaces. E1, E2, E3 are downcomer tubes extending from the upper part of the water space to the crowns of the furnaces, the lower ends of the tubes being bent so as to sweep off any steam bubbles adhering to the furnace walls, and at the same time to obviate any tendency for an upward circulation to take place through the tubes. In the locomotive boiler shown, a downcomer tube M1 extends from a trough K between the fire-box N and the outer shell A, and a tube M2 from the trough K enters the lower end of a cross-water tube O. (*Sealed.*)

END OF THE ONE HUNDRED AND NINTH VOLUME.

THE UNIVERSITY COLLEGE OF SOUTHAMPTON.

LECTURER IN MECHANICAL ENGINEERING.

Applications are Invited for the above POST, at a salary of £350 per annum.

Applications to be sent in by July 5th to the REGISTRAR from whom particulars may be obtained. H 150

INDIAN EDUCATIONAL SERVICE.

(1) BENGAL. SIBPUR CIVIL ENGINEERING COLLEGE.

Professor of Mechanical ENGINEERING and SUPERINTENDENT OF WORKSHOPS. Should have taken Mechanical Science Tripos, Cambridge, or equivalent degree or diploma, and possess practical experience.

Commencing pay Rs. 750, rising by Rs. 50 to Rs. 1250 a month (plus overseas allowance Rs. 250 a month in case of candidate with non-Indian domicile), for candidate with special qualifications. Free quarters provided.

NOT IN THE INDIAN EDUCATIONAL SERVICE.

(2) BENGAL. SIBPUR CIVIL ENGINEERING COLLEGE.—INSTRUCTOR IN MECHANICAL DRAWING. Should have had experience in a Mechanical Engineer's Drawing Office, and be capable of producing finished drawings of special machinery from rough sketches.

Candidates should submit their applications in covers, marked "U.A.," and addressed to the SECRETARY, Board of Education, Victoria and Albert Museum, South Kensington, S.W.7. Scottish candidates should apply to the SECRETARY, Scottish Education Department, Whitehall, London, S.W. 1. H 335

COUNTY BOROUGH OF WEST HAM.

MUNICIPAL TECHNICAL INSTITUTE, ROMFORD ROAD, STRATFORD, E. 15.

Applications are Invited for the following posts:—

HEAD OF DEPARTMENT OF MATHEMATICS.

Salary £475—£30—£700 per annum. Must have degree of British University with honours in Mathematics.

ASSISTANT LECTURERS AND DEMONSTRATORS IN

(a) Civil and Mechanical Engineering;
(b) Physics.

Salary £350—15—£525 per annum. Must be graduates of British University.

The initial salary will be fixed according to qualification and experience. Duties to commence in September next.

The above salaries await the confirmation of the Council, and should any alterations be made therein particulars will be forwarded to applicants for the positions.

Applications, with particulars of qualifications and experience and copies of recent testimonials, should be sent to the PRINCIPAL, Municipal Technical Institute, Romford Road, Stratford, E. 15, not later than 9th July, 1920. H 342

DARLINGTON EDUCATION COMMITTEE. TECHNICAL COLLEGE.

Principal: R. M. CAVEN, D.Sc.

Applications are Invited for the following POSTS:—

(a) HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING, PHYSICS AND PURE MATHEMATICS. Commencing salary £350 per annum, rising by annual increments of £12 10s. to £400. Applicants are required to be Graduates of British Universities.

(b) ASSISTANT LECTURER IN ENGINEERING. Commencing salary £300, rising by annual increments of £12 10s. to £350. Preference will be given to Graduates of British Universities with practical engineering experience.

Further particulars and Forms of Application may be obtained from the undersigned, to whom completed Forms should be returned not later than 14th July, 1920.

A. C. HOYDE,
Director of Education and Secretary.
June, 1920. H 68

NORTHAMPTON POLYTECHNIC INSTITUTE, LONDON, E.C. 1.

MECHANICAL ENGINEERING DEPARTMENT. To meet the increasing demands for thoroughly up-to-date workshop instruction of the highest type, the Governing Body invites

Applications for the following APPOINTMENTS:—1. A WORKSHOP SUPERINTENDENT, at a commencing salary of £350 per annum. Candidates must have thorough experience of tool making and precision gauge making, and general modern workshop methods and organisation. 2. A WORKSHOP INSTRUCTOR, with first-class practical experience of tool making and precision gauge making, at a commencing salary of £375 per annum. The holders of these appointments, if otherwise qualified, will be eligible for pensions under the non-contributory scheme of the Teachers' Superannuation Act (1918).—For further particulars and forms of application, apply to R. MULLINBUX WALMSLEY, D.Sc., Principal. H 331

Secretary Wanted by a Firm in the Steel Trade and Allied Industries. Applicants must be capable Accountants and have had thorough training and sound experience in Commercial and Office Management and Organisation, control of Accounts, Finance and Costing.—Address, in confidence, H 371, Offices of ENGINEERING.

Buyer, must have experience in markets for Machined Components Motor Car Details, REQUIRED by large Motor Company in South of England. Good permanent position to suitable man.—Write, giving full particulars of previous experience and salary required, to BOX BUYER, c/o Advertisement Department, 5, New Bridge Street, London, E.C. 4. H 341

HANDBOOK OF SHIP CALCULATIONS, CONSTRUCTION AND OPERATION,

By CHARLES H. HUGHES.

The first Handbook compiled with the purpose of assembling in a single volume, in convenient form practical data for every-day reference. It represents many years of collection and classification of material, gathered primarily for the every-day use of Mr. Hughes. No merely theoretical calculations are included. Upwards of 700 pages, with over 150 illustrations. Convenient size, bound in full flexible leather. Printed in clear type on good paper.

Engineering says:—"A volume which gathers within its 740 pages an immense amount of practical information of great value to all those interested in the design, construction and maintenance of ships and their machinery and fittings."

Write for Descriptive Booklet, sent Post FREE.

HANDBOOK OF MODERN AERONAUTICS

By ARTHUR W. JUDGE,

Assoc. R.C.S., Wh.S., Assoc. M. Inst. Auto. E., &c., &c.

This Handbook is designed to fill the need for a single volume of convenient size, containing all available aeronautical facts, data and tables that those interested in the practical side of aeronautics need. There is no similar book and in its compilation the author has made *practical value and utility* his first consideration. Containing over 1000 pages, packed with flying facts and figures, it comprises a handy book of reference for Aeronautical Engineers and Pilots, Manufacturers, Designers, Draughtsmen, the Works Staff and the Student.

A SUPER-MOLESWORTH.

The Aeroplane says:—"Mr. Judge has collected a vast amount of information relating to aeronautical engineering into a kind of Super-Molesworth. . . . Altogether the book should prove extremely useful."

FREE. Send for the Illustrated Folder describing the work and giving full details of its contents.

The Library Press Limited, 1, Portugal Street Buildings, Portugal St., London, W.C. 2

"This is a book valuable alike to the enterprising architect and the keen business man."—Building World, May 10, 1919.

THE DESIGN OF FACTORY AND INDUSTRIAL BUILDINGS.

By ERNEST G. W. SOUSTER, A.R.I.B.A.

DEMY 8VO. 170 PAGES. With 96 ILLUSTRATIONS AND EXPLANATORY DIAGRAMS.

Price 10s. 6d. net (post free, 11s. 3d. home and abroad). Cash with order.

PUBLISHED BY SCOTT, GREENWOOD & SON, 7456
8, Broadway, Ludgate, London, E.C. 4.

Thermodynamics for Engineers

By J. A. EWING, K.C.B., LL.D., D.Sc., F.R.S.,
Principal and Vice-Chancellor of the University of Edinburgh.

Demy 8vo. With 99 text-figures. 30s. net.

This volume treats the subject mainly from an engineering standpoint, but with sufficient generality to be useful to students of physics. The author's method is first to make readers familiar with the physical bearing of the fundamental ideas by means of an elementary introduction and by dealing with practical problems in the theory of heat engines and of refrigeration. After this, a more mathematical treatment is given of general thermodynamic relations and the usual equations are derived.

"Sir J. A. EWING'S new treatise meets a long-felt want."—*Engineering*, H 312

CAMBRIDGE UNIVERSITY PRESS
FETTER LANE, LONDON, E.C. 4: C. F. CLAY, MANAGER

Works Manager, Applications—which will be treated as strictly confidential—are INVITED for POSITION with London firm manufacturing motor cars. Experience in modern methods of production essential.—Address, H 417, Offices of ENGINEERING.

Machine Tool Co. Requires SALES MANAGER. Must be fully experienced Machine Tool Expert and Valuer. Salary and participation. — Write full particulars, experience, remunerations, etc., to O. S., Room 590, Salisbury House, London Wall, E.C. H 378

Required by General Engineering Company in India, an ASSISTANT WORKS MANAGER, to take charge of Millwrighting, Machinery Plant and Power House. Age about 26, single.—Reply fully, stating age, experience and salary required, S.S. 619, c/o DEACON'S, Leadenhall Street, London, E.C. 3. H 344

Estimators Required in London Office, preferably with knowledge of Boiler and Pipework Installations.—Address, stating experience, age and salary required, H 1[illegible], Offices of ENGINEERING.

Well-educated Youth Required for Laboratory in Engineering Works, for Pyrometric and Microscopic work.—Write stating age, experience and salary required to BOX 1227, WILLINGS, 125, Strand, W.C. 2. H 374

A London Firm are Open to RECEIVE APPLICATIONS from TRAVELLERS who have had experience in the handling of large orders for Drop Forgings up to 20 lbs. weight. Reply giving particulars of connection and terms in confidence.—Address, H 397, Offices of ENGINEERING.

Assistant Chemists for Shift Work and a SENIOR ASSISTANT WANTED in Iron and Steel Works Laboratory. Address, stating age, experience, and salary required The Secretary, Consett, Iron Co., Consett, Co. Durham. H 406

Assistant Locomotive SUPERINTENDENT REQUIRED by the GOVERNMENT of the FEDERATED MALAY STATES, for three years' service in the first instance, with prospect of permanency. Salary 400 dollars per month, rising by annual increments of 25 dollars per month to 500 dollars per month, with a temporary war bonus of 30 per cent. of salary. (The sterling value of the Straits dollar is fixed by Government at 2s. 4d.) Free passages provided. Candidates, not over 35 years of age, and preferably unmarried, who must have served an apprenticeship as a Mechanical Engineer in a Locomotive Builder's or Railway Locomotive Works, preferably possessing a knowledge of carriage and wagon work, laboratory work, Metallurgy and Electricity, should apply at once, by letter, giving age and brief details of experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/F.M.S. 9016. Applicants must have served in some branch of His Majesty's Forces during the late war, unless satisfactory reasons for not having done so can be furnished. H 343

Engineer.—Large Chemical Manufacturing Company REQUIRE first-class MAN, to be responsible for constructional work, maintenance and efficient working of manufacturing and power plant.—Address, H 401, Offices of ENGINEERING.

Assistant Engineer Required at large London Power Station, to take charge of eight-hour shift. Must have had good mechanical and theoretical training and experience of running large high tension A.C. Turbo-Generator Plant.—Address, stating age and experience, H 391, Offices of ENGINEERING.

Civil Engineering ASSISTANT REQUIRED temporarily for Drawing Office. Must be a good draughtsman, experienced in steel and general building construction, able to survey and level.—Apply, stating age, full particulars of experience and salary required, enclosing copies of recent testimonials, to OFFICER IN CHARGE OF WORKS, H.M. Dockyard, Sheerness. H 304

Assistant Civil Engineers WANTED for maintenance and small construction work on Railways in Cuba. Salary £600 to £660 per annum. Applicants should be about 25 years of age and single, and have been regularly trained in the profession. Preference given to applicants who can speak Spanish. Write "E. C.," c/o J. W. VICKERS & Co., Ltd., 5, Nicholas Lane, London, E.C. 4. H 341

RANGOON PORT COMMISSIONERS.

Applications are Invited for the POST of ASSISTANT CIVIL ENGINEER, experienced on Dock and Port work, and preferably with practical knowledge of the design and construction of reinforced concrete wharves. Applicants should be between 25 and 30 years of age. The engagement in the first instance will be for three years. The salary is 650, 700 and 750 rupees per month during the three years, successively, without any other allowances. Free first class passage to Rangoon and £10 for expenses on voyage.

Applications to be made only on a form (to be obtained with full particulars from the undersigned), not later than the 6th July, 1920.

OGILVY GILLANDERS & CO.,
Agents, Rangoon Port Commissioners.
R.1967. 67, Cornhill, London, E.C. 3.
21st June, 1920. H 398

Required, for Service under the GOVERNMENT OF INDIA, CIVIL ENGINEERS with special experience in drainage, waterworks, and other sanitary engineering works.

Nine appointments. Four Engineers, two to rank as Superintending Engineers, and five Assistant Engineers.

Generally speaking, applicants for the appointments as Engineers should be not less than 30 years of age, and applicants for the junior posts should not exceed 27, but there are two appointments as Assistant Engineers with age limit 26–35. Pay, which will in all cases be according to age, will be approximately the same as that of corresponding appointments in the Indian Public Works Department.

All applicants should have a good engineering degree, or have passed the A.M.I.C.E. examination, and must have had practical experience in drainage and waterworks.

Full particulars and forms of application can be obtained from the SECRETARY, Revenue Department, India Office, Whitehall. Applications should be made without delay. H 379

The Sudan Government RAILWAYS AND STEAMERS DEPARTMENT REQUIRE the SERVICES of a MECHANICAL ENGINEER.

Rate of pay £E720 rising to £E900 per annum, plus a temporary war bonus of £E120 per annum. No income tax is charged in the Sudan. (£E1 = £1 0s. 6d. sterling.)

Candidates for the post must have had thoroughly good training and should possess a University degree or an A.M.I.C.E. Only first-class men both by training and character need apply.

It is desirable that candidates should have been trained in the works of a British Railway or a first-class Locomotive Builder's Works; they should also have held some position of responsibility and be able to organise and control workshops. Marine or shipbuilding experience will be a qualification.

The post becomes pensionable after two years of probation.

Candidates should be between 28–38 years of age.

Preferably single.

Strict medical examination.

Free passage provided.

Copies of testimonials to accompany the application, which should be marked "S.G.R. Mechanical Engineer," and addressed to the office of—

SIR A. L. WEBB, K.C.M.G.,
Queen Anne's Chambers,
Broadway,
Westminster, S.W. 1. H 411

Engineer Wanted as an assistant in large Textile concern in the Midlands. Age 21 to 26. Experienced with Steam and Gas power plant. Knowledge of Drawing. Electrical equipment, Millwrighting and Buildings desirable. Excellent opportunity for keen worker. Give full practical and technical training, with salary required.—Address, H 407, Offices of ENGINEERING.

SINGAPORE, STRAITS SETTLEMENTS.

WATER DEPARTMENT.

The Municipal Commissioners of Singapore

Require an Assistant Engineer (age 26–35), on a three years' agreement, with possible extension. He must have had a good technical education, a regular training as a Civil Engineer, and have a practical knowledge of Surveying, Levelling and Estimating, and at least three years' experience in works of Water Supply, including the collection, filtration, pumping and distribution of water, both in the design and in the construction of new works and in ordinary maintenance. Experience in the design and construction of reinforced concrete structures is desirable. Preference will be given to an Assistant who has passed the examination of the Institution of Civil Engineers as Assoc.M.Inst.C.E. Salary $2500 for the first, $7200 for the second, and $7500 for the third year, paid monthly in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. The pay of the appointment for the first year at this rate would be £833. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination. Applications stating whether married or single, age, and place of birth and giving details of education, training, and experience generally, and in waterworks particularly, and referring to all the above requirements seriatim, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY & PEIRCE, MM.Inst.C.E., 180, Hope Street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 13th July, 1920. H 370

Appointments Open continued on page 4.

BULL'S METAL & MELLOID CO.

HEAD OFFICE AND WORKS: LIMITED.
YOKER, near GLASGOW.
TELEGRAMS: "MELLOID, YOKER."
BULL'S METAL.—Propellers, Bars, Sheets, Pump Rods, Valve Spindles, Condenser Stays & Plates, &c.
MELLOID. (Reg. Trade Mark and Patented.)—Condenser Tubes, Plates and Stays, Boiler Tubes, Stays and Plates, Fire-box Plates, Bars, Sheets, Valves, &c.
WHITE METALS.—Babbitts, Plastic, &c. 1937

Engineer Wanted for Japan,

by English Company manufacturing a Speciality. Must be thoroughly experienced and a capable organiser. Good prospects for single man. —Address, in first instance, with copies of references, age, salary required and when at liberty, H 220, Offices of ENGINEERING.

Engineer Required for Iron-

works. Must have had first-class Foundry and Machine Shop experience. Applicants should give full particulars of previous engagements, and state age and salary required. — Address, H 334, Offices of ENGINEERING.

Assistant Engineer

REQUIRED for the GOVERNMENT RAILWAY OPEN LINES DEPARTMENT, FEDERATED MALAY STATES, for three years' service, with possible permanency. Salary 400 dollars a month, rising by annual increments of 25 dollars a month to 500 dollars a month, with a temporary war bonus of 20 per cent. (The sterling value of the dollar is at present fixed by the Government at 2s. 4d.) Free passages. Candidates must be under 35, and preferably single, and must be qualified Civil Engineers with experience of Railway Maintenance. They must also be capable of setting out and supervising the construction of new works. Apply at once, by letter, giving age and brief details of experience to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/F.M.S. 9636. Applicants must have served in some branch of His Majesty's Forces during the late war, unless satisfactory reasons for not having done so can be furnished. H 306

Assistant Engineers

REQUIRED for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for three years' service with prospect of permanency. Salary 400 dollars per month, rising by annual increments of 25 dollars per month to 450 dollars per month for the period of the agreement, then rising by annual increments of 25 dollars per month to 600 dollars per month with prospects of further advancement. (The sterling value of the dollar is at present fixed by the Government at 2s. 4d.). A temporary war bonus of 20 per cent. is at present payable. Free passages provided. Candidates, age 25-35, preferably single, who have received a good theoretical training, preferably at a University, or at an Engineering College, recognised by the Institution of Civil Engineers, or have completed articles with Civil Engineers of standing, and passed the A.M.Inst.C.E. Examination, and in addition have had two years' practical experience, should apply at once, by letter, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/F.M.S. 9699. Candidates must have served in some branch of His Majesty's Forces during the late war, unless satisfactory reasons for not having done so can be furnished. H 307

H.E.H. THE NIZAM'S GUARANTEED STATE RAILWAYS CO., LTD.

ASSISTANT MECHANICAL ENGINEER.

The Directors are prepared to receive

Applications, by letter only,

from duly qualified candidates for APPOINTMENT on the above Railway as ASSISTANT MECHANICAL ENGINEER, with special knowledge of Signalling, to take charge of workshops.

Candidates must have received a good general and technical education, and preference will be given to those who have obtained a diploma or degree from a recognised engineering college. They must also possess a special knowledge of the manufacture of Signalling and inter-locking Apparatus and repairs to same, and be capable of generally superintending Engineering Workshops.

TERMS.—A three years' agreement in the first instance on a commencing salary of Rs. 600 to Rs. 750 per calendar month, according to age and qualifications, and first class free passage to India. Age about 28 years.

Applicants must give a full record of their career in chronological order, with dates, giving details of their general and technical education, training and subsequent experience, especially as to whether they have had similar experience with a Railway Company, with copies of any testimonials, certificates, etc., and details of service, if any, with H.M. Forces.

Full particulars, stating age, whether married or single, etc., as set out above, should be sent to the undersigned not later than 1st July. N.B.—The selected candidate will only be finally appointed subject to his passing a strict medical examination by the Company's Consulting Physician.

F. ADAMS,
Secretary.

Offices of the Company,
40, Old Broad Street,
London, E.C. 2. H 266

The Sudan Government

RAILWAYS & STEAMERS DEPARTMENT REQUIRE the SERVICES of TWO ENGINEERS for Shallow Draft Nile Steamers — preferably in possession of Board of Trade Certificate.

Rate of pay £E300 rising to £E390 per annum, plus a temporary war bonus of £E120 per annum. No income tax is charged in the Sudan (£E1 = £1 0s. 6d. sterling.)

No messing allowed.

Strict medical examination.

Age between 30—35 years.

Capable men eligible for higher posts.

Copies of testimonials to accompany the application, which should be marked "S G R Steamer Engineer" and addressed to the office of—

SIR A. L. WEBB, K.C.M.G.,
Queen Anne's Chambers
Broadway,
Westminster,
S.W.1 H 430

MUSGRAVE BROS.,

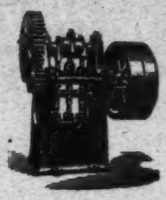
Crown Point Foundry, LEEDS.

Makers of all Descriptions of

HYDRAULIC MACHINERY.

Including—

Pumps, Accumulators, Fixed and Portable Rivetters, Valves, Flanging and Forging Presses, Cranes and Special Tools for Bridge Builders, Loco. Makers, Boiler Makers, Ship-Builders, Iron and Steel Works, Docks, &c.



8472

Contractors to the Home and Foreign Governments.

OIL MILL MACHINERY of all descriptions.

W. B. BROWN & CO. (BANKHALL), Ltd

GLOBE WORKS LIVERPOOL.

HIGH GRADE. 7385

STEEL WIRE ROPES FOR ENGINEERING.

There are too many advantages

to describe in this space attaching to the speedy reliability of the

"SKATOSKALO"

PNEUMATIC SCALING TOOL

for removing scale

from Babcock, Stirling and other water-tube boilers, evaporators and condensers and for Lancashire boiler scaling, rust removing, etc. But they are all given in my catalogue.

Write:

FRANK GILMAN,
Sole Maker, 9, WESTFIELD RD.,
BIRMINGHAM

Wanted, at Once, for Large

Blast Furnace, Coke Oven and By-Product Plant on the North-East Coast, a thoroughly qualified WORKS ENGINEER. Must have had experience with the working of modern plants.

Write, in the first instance, stating experience, with full particulars of same, age and salary expected, to BOX "M," KIDDS' Advertising Agency, Middlesbrough. H 179

Mechanical Engineer for

small factory, to take charge Drawing Office, also to supervise design and manufacture press tools and jigs.—Write stating age, experience and salary required to BRITISH THOMSON-HOUSTON CO., Fittings Factory, Lower Hillmorton Road, Rugby. G 983

Electrical Crane Specialists

in Manchester HAVE a VACANCY for an EXPERT ENGINEER able to deal with technical correspondence and specifications. State age, details of experience and salary required.—Address, H 354, Offices of ENGINEERING.

Estimating Engineer Assis-

TANT WANTED, experienced in making out Tenders, handling correspondence and office routine; preferably with practical knowledge of cranes, structural and electrical work. — Address, stating age, experience, salary required, THE ANDERSON-GRICE CO., LTD., Carnoustie. H 333

Engineer Assistant Buyer

WANTED in Export Merchant's Office. Knowledge of General Industrial Engineering, also French and English languages, essential.—State age, experience, salary required, to BOX R.P., c/o DAVIES & Co., Finch Lane, E.C. 3. H 338

Assistant Engineer,

2nd Grade, REQUIRED for service on the GOLD COAST HARBOURS (Accra and Seccondee). Salary £600 per annum. Free quarters and first-class passages. Liberal leave in England on full salary after each tour of 8 to 12 months residential service. Candidates who are duly qualified Civil Engineers and have had experience on an Engineers' or Contractors' staff in the actual construction of Harbour Works should apply at once, by letter, giving age and brief details of experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/Gold Coast 9603. Candidates must have served in some branch of His Majesty's Forces during the late war, unless satisfactory reasons for not doing so can be furnished. H 335

Skilled Erector Required for

erecting Large Tanks, Stills, Pipes, Pumps and General Engineering, capable of taking control of labour outdoors.—Address, H 264, Offices of ENGINEERING.

Works Management.—A

large Electrical Manufacturing Concern in the North of England REQUIRE a CAPABLE ENGINEER to supervise the manufacture of large size electrical machines. Applicants must have had a practical workshop experience and technical training, and possess executive ability, and a knowledge of modern methods of quick production. To a really capable man with the necessary qualifications the position offers good prospects. Applications should state age, qualifications, previous positions held, and salary required.—Address, H 315, Offices of ENGINEERING.

Works Management.—A

VACANCY OCCURS in the Works of a manufacturing concern for a Thoroughly Qualified ENGINEER, to fill a responsible position. Must be well-educated, possess up-to-date technical knowledge and used to exercising executive control over large numbers of workpeople. First-class general experience of machine and erection shop work in connection with steam turbine practice essential.

Applications, which will be treated in confidence, should state age, qualifications, previous experience, and salary required.—Address, H 294, Offices of ENGINEERING.

RANGOON MUNICIPALITY.

BURMA.

Wanted, a Resident Engineer

with a thorough practical experience in Reinforced Concrete Work, Erecting and Maintenance of Ropeways for handling materials for the construction of a 20 million gallon reinforced concrete Service Reservoir.

Candidates must state salary for which they are prepared to engage for a period of service of two years, extendable at the option of the Municipal Committee to a maximum period of four years.

Applications to be made only on a form (to be obtained with full particulars from the undersigned) not later than the 30th June.

OGILVY, GILLANDERS & CO.,
Agents for the Rangoon Municipality,
67, Cornhill, London, E.C. 3.

R. 1902.
June 14th, 1920. H 139

Draughtsman (Structural)

REQUIRED at once; London district; capable of designing, estimating and detailing steel framed buildings, factories, &c., must be competent, theoretical and practical man. Apply, stating salary required, experience, &c.—Address, H 402, Offices of ENGINEERING.

Draughtsman, First-Class,

WANTED for small General Engineering Works, about 50 miles from London, turning out mining machinery, Conveyors, &c., must be used to taking out quantities and estimating, state age, whether married or single, and salary required, by letter only to X.Y.Z. c/o CHARLES BARKER AND SONS, LTD., 31, Budge Row, E.C. 4. H 408

Two Experienced Chemical

DRAUGHTSMEN WANTED at once.—Apply, by letter only, J. W. MCKINLAY, Glencairn, Bearsden, Glasgow. H 243

Draughtsman, experienced

on Motor Body work, REQUIRED. Full particulars and salary required, to H 347, Offices of ENGINEERING.

Reinforced Concrete Designer,

with good theoretical knowledge and designing routine, WANTED at once.—Apply, PETER LIND & CO., Reinforced Concrete Engineers and Contractors, 2, Central Buildings, Westminster, S.W. 1. H 269

Railway Carriage and Wagon

DRAUGHTSMAN WANTED. Salary to start £270 per annum. State age and experience.—Address, H 350, Offices of ENGINEERING.

Draughtsmen.—Two Construc-

tional Draughtsmen with experience in both light and heavy work. Must be efficient in design and detail. Good prospects for suitable men.—Address, stating age, experience and salary required, to H 364, Offices of ENGINEERING.

Draughtsman - Designer for

special machine tools. Must be conversant with progressive engineering methods. State fully experience, age and salary required.—Address, H 285, Offices of ENGINEERING.

Wanted, Junior Jig and Tool

DRAUGHTSMAN,—Address, stating age, experience and salary required, H 286, Offices of ENGINEERING.

Telephone Draughtsman

REQUIRED for London office, used to circuits, manufacturing and exchange detail.—Application by letter only, stating age, experience and salary required, to the RELAY AUTOMATIC TELEPHONE CO., LTD., Marconi House, Strand. H 377

Draughtsmen Wanted for

Railways in Cuba. Senior Assistant—salary £600 to £650; Junior Assistant—salary £500 to £550. Applicants should be not more than 30 years of age and single. Experience of railway construction and maintenance drawing office work essential. Preference given to applicants who can speak Spanish.—Write "H.P.," c/o J. W. VICKERS & Co., Ltd., 5, Nicholas Lane, London, E.C. 4. H 340

Wanted, Good Machine Tool

DESIGNER, 10 years' experience with first-class firm. References, salary, and when at liberty.—Address, G 359, Offices of ENGINEERING.

Wanted, for Midlands, Ex-

perienced DRAUGHTSMAN, accustomed to Heating and Ventilating Work.—Address, stating age, experience and salary required, H 170, Offices of ENGINEERING.

Draughtsman Wanted,

Smart YOUNG MAN for Water Tube Boiler Work, one with experience in Power Station Layouts preferred. Good opening for suitable applicant. —State age, experience and salary required, to RICHARDSONS, WESTGARTH & CO., LTD., Middlesbrough. H 171

Draughtsman, with experi-

ence in design and construction of Centrifugal Pumps, preferably with electrical knowledge. —Address, stating age, details of training, and salary required, H 258, Offices of ENGINEERING.

Draughtsman Required, with

experience in rice and sugar milling machinery. State age, experience and salary required.—Address, H 238, Offices of ENGINEERING.

Required, Three First-rate

DRAUGHTSMEN, by a leading firm of Consulting Engineers, Westminster, two for bridge and constructional work, some mechanical experience desirable, and one for design of dock, harbour and general contractors' work.—Address, H 303, Offices of ENGINEERING.

Required for Large Factory

about 11 miles West of London, an Experienced MECHANICAL DRAUGHTSMAN accustomed to layouts of factory plant and mill gearing and conversant with structural steel design. Applicants should state briefly particulars of training and subsequent service with dates. Salary £5 to £6 per week according to qualifications.—Address, H 218, Offices of ENGINEERING.

Wanted, Structural Steelwork

DRAUGHTSMEN, Senior and Junior. Permanent positions for experienced men used to all classes of Steelwork.—Particulars of age, experience and salary, to CHIEF DRAUGHTSMAN, BRAITHWAITE & Co., Crown Bridge Works, West Bromwich. H 207

Appointments Open continued on page 153.

For Continuation of Small Advertisements see pages 150-1 and 153-4-5.

INDEX TO ADVERTISEMENTS.

	Page
A-1 Manufacturing Co.	68
Adaptable Moulding Machine Co.	131
Aerial Ropeways Transporters, Ltd.	8
Aerograph Co., Ltd.	110
Agricultural & General Engineers Ltd.	70
Allas Shipbuilding Co., Ltd.	142
Aircraft Disposal Co., Ltd.	26
Airostyle & Lithos Ltd.	28
Aldrich Pump Co.	134
Alldays & Onions, Ltd.	138
Allen, Edgar, & Co., Ltd.	129
Allen-Liversidge, Ltd.	127
Allen, W. H. Sons & Co. Ltd.	79
American Car & Foundry Co.	148
American Steel Export Co.	90
Angus, Geo. & Co., Ltd.	114
Apex Steel Co. Ltd.	109
Archdale, Jas., & Co., Ltd.	104
Armstrong Mfg. Co.	30
Armstrong, Stevens & Son.	40
Armstrong, Sir W. G. Whitworth & Co., Ltd.	64
Armstrongs & Main, Ltd.	136
Ash, Joseph & Son	113
Ashmore, Benson, Pease & Co.	14
Asquith, Wm., Ltd.	17
Atlas Diesel Co., Ltd.	110
Auld, David, & Sons, Ltd.	10
Austin Motor Co., Ltd.	146
Avery, W. & T., Ltd.	53
Avonside Engine Co.	141
Bagnall, W. G., Ltd.	134
Bailey, Sir W. H. & Co., Ltd	62
Baldwin Loco. Works	140
Baldwin's, Ltd.	132
Barclay, Andrew, Sons & Co.	143
Barker, Spink, Lease & Co.	120
Barry, Henry & Co.	6
Bath, T., & Co.	115
Baylis, Jones & Baylis, Ltd.	10
Baynes, Charles, Ltd.	11
Beardmore, Wm. & Co.	68
Beaudry & Co.	6
Beebee, A.	116
Beldam Pkg. & Rbr. Co.	112
Bellamy, John, Ltd.	4
Bellis & Morcom, Ltd.	119
Bennis, Ed. & Co., Ltd.	72
Bergius Launch & Engine Co. Ltd.	119
Berriman, Ltd.	110
Bessemer, Henry & Co. Ltd.	89
Bever, Dorling & Co., Ltd.	1
Beyer, Peacock & Co.	139
Birm. Alum'n. Castings Co.	106
B'ham Battery & Metal Co.	149
B'ham R. C. & Wagon Co.	26
Blair, Campbell & McLean	128
Blakeborough & Sons, Ltd.	42
Booth, John, & Sons	48
Booth, Joseph, & Bros., Ltd.	76
Boving & Co., Ltd.	94
Bowran, Robert, & Co.	118
Bradley & Craven, Ltd.	7
Bradley Pulveriser Co.	31
Braime, T. F. & Co., Ltd.	131
Braithwaite & Co.	147
Brandon Bridge Building Co.	142
Brecknell, Munro & Rogers	28

	Page
Brett's Patent Lifter Co.	1
Bridge, D., & Co.	137
Brightside Foundry & Eng. Co.	141
Brignolio Machinery Ltd.	133
Brit. Aluminium Co., Ltd.	1
British Hydrite & Asbestolite Works, Ltd.	41
Brit. Fire App. Co., Ltd.	1
British Insulated & Helsby Cables, Ltd.	68
Brit. L.M. Ericsson Co., Ltd.	124
B.M.T. Corporation	31
British Mannesmann Boiler Co.	118
British Oil Products	115
British Oxygen Co., Ltd.	126
British Piston Ring Co.	130
British Reinforced Concrete Eng. Co., Ltd	78
British Rolling Mills, Ltd.	136
Brit. Steam Specialties	119
B.T.H. Co.	91
British Vac. Cleaner Co.	126
Briton Ferry Steel Co. Ltd.	96
Bromell Patents Co. Ltd.	30
Broom & Wade, Ltd. 116 &	146
Brotherhood, P., Ltd.	79
Broweth, Lindley, & Co.,	15
Brown Hoisting Mach'ry Co.	101
Brown, John, & Co., Ltd.	126
Brown, Lenox & Co., Ltd	106
Brown, W. B. & Co. Ltd.	4
Browne & Co.	130
Brownlie & Green, Ltd.	152
Brundrit, Joseph	116
Brunton & Trier	149
Buck & Hickman	91
Bucyrus Company	80
Budenberg Gauge Co., Ltd.	113
Buhring's Pat. Water Co.	110
Bullard Machine Tool Co.	138
Bullivant & Co., Ltd.	114
Bull's Metal & Melloid Co.	4
Burckhardt Eng. Works	118
Burmeister & Wain, Ltd.	98
Burton, Griffiths & Co.	101
Butler Machine Tool Co.	107
Butler, Samuel & Co., Ltd.	114
Butterley Co., Ltd.	130
Cambridge & Paul Inst. Co	1
Cameron, John, Ltd.	86
Cammell Laird & Co., Ltd.	6
Campbell & Calderwood	126
Campbelle & Hunter, Ltd.	1
Cape Asbestos Co.	9
Carbon Steel Co.	89
Carron Co.	87
Carruthers, J. H., & Co., Ltd.	97
Chadburn (Ship) Tele. Co.	111
Chambers, Scott & Co., Ltd.	132
Chaplin, Alex. & Co., Ltd.	138
Chas. with Thos. Ltd.	94
Church St., Machinery and Engineering Corp.	89
Cie des Moteurs Rationnel	144
Clay Cross Co., Ltd.	144
Clayton & Shuttleworth,	81
Clayton, Son & Co., Ltd.	139
Cleveland Bridge & Eng. Co.	20
Clifton & Baird, Ltd.	48
Clifton & Waddell	24
Clyde Structural Iron Co.	14
Clyne Engineering Co.	114

	Page
Coats Machine Tool Co.	108
Cochran & Co., Annan, Ltd.	1
Coles, Henry J., Ltd.	109
Colo Merchant & Morley, Ltd.	92
Colley Eng. & Mach. Co.	84
Coltman, W. W., & Co.	126
Columbia Steel & Eng. Co.	111
Colville, D., & Sons, Ltd.	99
Consolidated Brake & Eng. Co.	6
Consolidated Construction Co., Ltd.	147
Consolidated Pneu. Tool Co.	83
Conveyor & Elevator Co.	6
Cooke, E. J.	15
Cooke, James, & Son	151
Cousland, A., & Son	146
Coventry Chain Co., Ltd.	115
Cradley Boiler Co., Ltd.	139
Cradock, G. & Co., Ltd.	12
Craig & Donald, Ltd.	4
Craven Bros. (Manchester)	38
Cromwells' Ltd. Chekko	28
Crosby Valve & Eng. Co.	19
Crossley, H. P. & Ackroyd	13
Cushman Chuck Co.	116
Daniels, T. H. & J., Ltd.	118
Dangerfield, W. & J.	148
Dashk, H. & T.	103
Darlington Forge Co., Ltd.	104
Davenport Eng. Co., Ltd.	115
Davey, Paxman & Co., Ltd.	78
Davies & Metcalfe, Ltd.	5
Davis, E. J. & Co.	1
Davis & Primrose, Ltd.	1
Davy Brothers, Ltd.	121
Dawson & Downie, Ltd.	114
Day, Summers & Co., Ltd.	106
Delta Metal Co., Ltd.	149
Dampster, Moore & Co., Ltd.	8
Denison, S. & Son, Ltd.	112
Dickie, George & Son	127
Dobbie McInnes Ltd.	25
Denkin Co. Ltd. (The Bryan)	126
Douglas & Grant, Ltd.	120
Douglas, Lawson & Co.	120
Doxford, Wm., & Son., Ltd	126
Drum Engineering Co.	113
Drummond Bros., Ltd.	6
Drysdale & Co., Ltd.	114
Dunkerley C. C. & Co., Ld.	27
Dunlop Rubber Co., Ltd.	156
E. Ferry Rd. Eng. Wks. Co.	1
Electric Control, Ltd.	117
Electro-Mech. Brake Co.	139
Electro-Metals, Ltd.	14
Electromotors, Ltd.	61
Ellison, George	113
Elliston, Evans & Jackson	19
Engineering Supplies Ltd.	114
English Electric Co. Ld.	67
Enthwiste & Gass, Ltd.	114
Escher, Wyss & Co.	142
Everitt & Co.	48
Ewart Chainbelt Co., Ltd.	29
Expanded Metal Co., Ltd.	27
Fairley, James, & Sons	146
Farmer & Co.	19
Farrar Boiler Works, Ltd.	114
Ferguson Bros., Ltd.	47
Ferodo Ltd.	73
Fielding & Platt, Ltd.	41
Fife Forge Co., Ltd.	111

	Page
Figee, Ltd.	52
Findlay, Alex. & Co., Ltd.	100
Firth, Thos., Ltd.	85
Fletcher, George, & Co., Ltd.	9
Foster Brothers, Ltd.	114
Foster Instrument Co.	78
Fowler, John & Co. (Leeds)	134
Franco & Morgan	12
Friedenthals, Ltd.	114
Fry's Metal Foundry	134
Fuller-Lehigh Co.	121
Fullerton, Hodgart & Barclay	105
Galloways, Ltd.	13
Gardiner, T.	143
Gardner, L., & Sons, Ltd.	86
Garthoerrie Eng. & Forge Co.	1
General Electric Co., Ltd.	94
Gibbins, H., & Co.	146
Gilbertson, W., & Co., Ltd.	156
Gilman, Frank, Ltd.	4
Glasgow Iron & Steel Co.	144
Glenfield & Kennedy, Ltd.	110
Goodwin, Barsby & Co.	114
Govan Shafting Eng. Co.	137
Grafton & Co.	119
Grant, Ritchie & Co., Ltd.	122
Graphite Products, Ltd.	113
Great Western Railway Co.	89
Green & Boulding, Ltd.	149
Greenwood's Standard Gear Cutting Co., Ltd.	6
Gresham & Craven, Ltd.	128
Grieson-Russell Co.	45
Gunther, W., & Sons	113
Gutta Percha & Rubber Ltd.	1
Haddields, Ltd.	78
Hall, R. J., & Co., Ltd.	8
Hall, J. & E., Ltd.	113
Hall, J. P., & Sons, Ltd.	10
Ham, Baker & Co., Ltd.	92
Hamworthy Eng. Co. Ltd.	123
Hannan & Buchanan	149
Hardy & Padmore, Ltd.	81
Harris Patent Feed Water Filter, Ltd.	30 & 118
Hart & Foster, Ltd.	120
Harvey Engineering Co., Ltd.	88
Harvey, G. A. & Co. (Lond.)	10
Harvey, G. & A., Ltd.	22
Haslam, Peter & Eng. Co.	144
Hawthorn, R. & W., Leslie and Co., Ltd.	1
Hayward-Tyler & Co., Ltd.	139
Head, Wrightson & Co.	1
Heap, Joshua, & Co., Ltd.	63
Heath & Co., Ltd.	116
Heath & Sereva	16
Heavy Stampings, Ltd.	22
Heenan & Froude, Ltd.	80
Henderson, J. M., & Co.	135
Hendry, James, Ltd.	149
Herbert, Alfred, Ltd.	75
Herbert, S. G., Ltd.	128
Heywood, S. H., & Co., Ltd.	1
Hick, Hargreaves & Co.	48
Hindley, E. S., & Sons	10 & 15
Hingley, N., & Sons, Ltd.	115
Hobdell, Way & Co., Ltd.	25
Hoffmann Mfg Co., Ltd.	80
Holding, J. & Co., Ltd.	7
Holdsworth & Sons, Ltd.	16
Hollings & Guest, Ltd.	16
Holmes, J. H., & Co.	10
Holt & Willetts	122

	Page
Hope, Henry, & Son, Ltd.	52
Hopkinson, J., & Co., Ltd.	92
Horsfall & Mason	119
Horseley Bridge & Eng. Co.	17
House, F. & Co.	113
Howden, J. W., & Co.	21
Howard Foun. Eng. Co.	129
Howden, James, & Co.	97
Howes & Burley	97
Hudswell, Clarke & Co., Ltd.	149
Hull Gen. Patt. M'k'g. Works	110
Humdee Engine Co. Ltd.	141
Hunt & Mitton, Ltd.	16 & 149
Hurst, Nelson & Co., Ltd.	86
Hyatt Ltd.	110
Hydraulic Gears Ltd.	90
India-Rubber, Gutta-Percha and Telegraph Works Co.	122
Incandescent Heat Co.	22
Ingersoll-Rand Co.	45
Ironike Co., Ltd.	91
Jack, Alexander & Co.	118
Jenkins, R., & Co.	25
Jennings, R. J.	1
Jensen & Dahl	10
Johnson & Phillips, Ltd.	100
Jones & Lamson Machine Co.	122
Jones & Shipman, Ltd.	79
Jonkopings Mekaverkstads A.B.	103
Kearns, H. W., & Co., Ltd.	8
Keith, J. & Blackman Co.	129
Kent, Geo., Ltd.	118
Kenyon, Alexander, & Co.	23
Kenyon, Wm., & Sons	11
Kilmarnock Eng. Co., Ltd.	102
Kirkstall Forge Co., Ltd.	156
Kitchen's Reversing Rudder & Locomotive Dynamo and Motor Co., Ltd.	42
Lancaster & Tonge, Ltd.	117
Lang, J., & Sons	46
Laurence, Scott & Co., Ltd.	44
Lea Recorder Co., Ltd.	118
Leathers Co. (Altrincham)	148
Le Bas, Edward, & Co.	111
Lee, Arthur, & Sons, Ltd	119
Leeds Eng. & Hydraulic Co., Ltd.	70
Leeds Forge Co., Ltd.	140
Legge, F., Thompson & Co.	149
Leroy, F., & Co.	120
Library Fines, Ltd.	8
Lidgerwood Mfg. Co.	144
Lilleshall Co., Ltd.	46
Lindsay, R. B., & Co.	92
Liverpool Refrig. Co., Ltd.	139
Lloyd, F. H., & Co., Ltd.	46
Lloyds Bank Ltd.	117
Lobnitz & Co., Ltd.	134
Lodge Plugs Ltd.	128
London Assurance	86
Low Temperature Carbonisation Ltd.	86
McGlinnis-Marshall Products Co.	136
McGowan, Wild, & Co.	8
McKenzie & Holland, Ltd.	98
McKie & Baxter	70
McRobie, John, & Sons	119
McNeil, Charles, Ltd.	112
Manlove, Alliott & Co., Ltd.	97

	Page
Manning, Maxwell & Moore Inc.	127
Manning, Wardle & Co., Ltd.	143
Markt & Co. (London)	116
Marsden, H. R., Ltd.	78
Marcites, S., & Son, Ltd.	18
Marshall, Sons & Co., Ld. 97 &	126
Massey, B. & S., Ltd.	1
Mather & Son, Ltd.	31
Mandsley Motor Co., Ltd.	93
Mayor & Coulson, Ltd.	96
Maxwell & Page	131
Meldrums, Ltd.	114
Merry-weather & Sons, Ltd.	13
Metallic Mfg. Co., Ltd.	110
Metallic Valve Co.	114
Metropolitan-Vickers Electrical Co., Ltd.	66
Metallurgical Co., Ltd.	127
Middleton Bros.	20
Middleton, Robt. & Co.	138
Mills, William, Ltd.	109
Milwall Engineering Co.	147
Mirrless, Bickerton & Day	123
Moorlands Engineering Co.	21
Motor Rail & Trac Co.	134
Mowbray, F. H.	147
Mumford, A. G., Ltd.	1
Munts, F. H. & Co., Ltd.	148
Mumming, H., Ltd.	139
Musgrave Bros.	4
Napier Bros., Ltd.	80
Nathan, H. L.	43
National Gas Engine Co., Ltd.	49
New Gutta Percha Co., Ltd.	152
Newall Engineering Co.	1
Newall's Insulation Co.	110
Newbold, Walter & Co.	139
Newton, Bean & Mitchell	148
Nichols Pump & Eng. Co.	114
Niles-Bement-Pond Co.	84
Normand, Arnold	18
Notcutt, Walter F., Ld.	18
Oakey, J., & Sons, Ltd.	120
Oil Well Supply Co.	83
Oxy-acetylene Welding Co.	127
Paisleys Ltd.	17
Parc, Ltd.	90
Parkinson, J. & Son.	114
Parsons, C. A., & Co., Ltd.	69
Partington Steel & Iron Co.	84
Patent Die-Casting Co.	121
Paterson Engineering Co.	114
Paul, Matthew, & Co., Ltd.	72
Peckett & Sons, Ltd.	140
Penman & Co., Ltd.	23
Perman & Co., Ltd.	117
Pigrath, Thos., & Co., Ltd.	152
Plibrico Ventilating & Eng. Co.	96
Plenty & Son, Ltd.	132
Pollock, Malcolm & Highgate	28
Pott, Cassels & Williamson	1
Pratchitt Bros.	114
Premier Cooler & Rfrg. Co. Ltd	126
Premier Gas Engine Co., Ltd.	120
Priestman Bros., Ltd.	135
Rahn-Larmon Co.	114
Ramshaw & Marshall, Ltd.	22
Ransome var. Mahr Mach. Co.	49
Ransomes, Sims & Jefferies	60
Reay Gearworks, Ltd.	113
Reddaway, F., & Co., Ltd.	122
Redman, C., & Sons	90

	Page
Redpath, Brown & Co., Ld.	126
Reid Gear Co.	135
Reyrolle, A., & Co., Ltd.	114
Rice & Co. (Leeds), Ltd.	126
Richardsons, Westgarth & Co.	129
Richmond Gas Stove and Meter Co., Ltd.	9
Robey & Co., Ltd.	85
Roe, Downs & Thompson	146
Ross & Duncan	5
Rowan, David, & Co.	148
Rowse & Co.	81
Royce Limited	1 & 20
Ruston Limited	24
Rudge-Whitworth, Ltd.	69
Russell, G., & Co., Ltd.	1
Russell John & Co. (Walsall)	178
Rubi-Togni Ltd.	88
Sankey, J., & Sons, Ld. 49 &	110
Schneider & Cie	97
Scott, David	85
Scottish Stamping and Eng. Co.	136
Scottish Tube Co., Ltd. 1 &	107
Seagers, Ltd.	16
Selson Engineering Co. 138 &	149
Shanks, Thomas, & Co.	114
Shaw, John, & Sons (Wol.)	134
Shore, Thomas & Son, Ltd.	113
Shotton Paper Co., Ltd.	96
Shuster, F. B. Co.	116
Simons, Wm., & Co., Ltd.	7
Sleeper & Hartley, Inc.	14
Smedley Bros., Ltd.	19
Smethwick Stamping Co.	22
Smith Bros. & Hill, Ltd.	114
Smith, R. J. & Co.	66
Smith & Coventry, Ltd.	12
Smith & Graves, Ltd.	44
Smith, S. & Sons, Ltd.	139
Smith, Sydney, & Sons	149
Smith & Co.	9
Somers, Walter & Co., Ltd.	33
Somerville, D. G. & Co., Ltd.	11
Southern, J. W., & Son, Ltd.	114
Spofford Tool Works	82
Sparklets & Gen. Mfg. Co.	1
Spencer, John, Ltd.	146
Spencer, W. H. & Co.	1
Standard Eng. Co.	118
Standard Piston Ring and Eng. Co., Ltd.	114
Steam Cyl. Lubricator Co.	130
Steel Co. of Scotland, Ltd.	19
Steel Pipe Co., Ltd.	37
Steinle, Leo. C.	103
Stephenson, R., & Co., Ltd.	141
Sterne, L., & Co., Ltd.	93
Sterling Metals Ltd.	143
Stern Ltd.	121
Steven & Struthers	131
Stewarts & Lloyds, Ltd. 1 &	79
Stoker, A., & Co.	127
Stone, J., & Co., Ltd.	114
Stothert & Pitt, Ltd.	128
Stuart & Co. (Stockton), Ltd.	120
Sturtevant Eng. Co., Ltd.	131
Sugden, T., Ltd.	119
Sulzer Bros.	85
Summerson, T., & Sons, Ltd.	1
Sun Shipbuilding Co.	84
Sutcliffe Brothers	5
Swift, George, & Sons, Ltd.	114
Tangyes Limited	49

	Page
Taylor & Challen, Ltd.	42
Telephone Mfg. Co., Ltd.	80
Thermotank Co.	115
Thomas & Bishop	114
Thompson, John (Wol.) Richmond Gas Stove and Meter Co., Ltd.	9
Thornycroft, J. I. & Co.	67
Tilghman's Pat. S. Blast Co.	81
Timbrell & Wright Machine Tool & Eng. Co., Ltd.	110
Tomey, Joseph, & Sons,	113
Tranter, W. J., Ltd.	20
Trewent, F. J., & Procter	1
Trier Bros., Ltd.	98
Triumph Stoker, Ltd.	139
Tubes Limited	1 & 127
Tubi-Togni Ltd.	88
Tuck & Blakemore, Ltd.	119
Tullis, D. & J., Ltd.	112
Tullis, J., & Sons, Ltd.	102
Turton, T., & Sons, Ltd.	116
Twoin' Patent Valve Gear	81
Union Transit Co.	1
United Metal Engraving Co.	90
United States Metallic Packing Co., Ltd.	124
United States Rubber Co.	83
Valor Company Ltd.	13
Variable Speed Gear Co.	88
Vaughan Crane Co., Ltd.	119
Vickers Limited	70 & 77
Vickers-Petbow Ltd.	65
Vosper & Co., Ltd.	1
Wakefield, C. C., & Co.	16
Walker Bros. (Wigan), Ltd.	13
Walker, James & Co.	18
Walker, Wm., & Sons,	17
Wallsend Slipway & Eng. Co., Ltd.	84
Ward, T. W., & Co.	118
Watson, Laidlaw & Co.	114
Wayzgood Otis, Ltd.	119
Webb & Son (Combe), Ltd.	143
Webster & Bennett, Ltd.	27
Weir, G. & J., Ltd.	71 & 139
Weldless Chains Ltd.	1
Weldless Steel Tube Co.,	112
Wellman Smith Owen Eng. Corp. Ltd.	95
Wells, A. C., & Co.	21
Werf Conrad	100
Western Wheeled Scraper Co.	98
Westinghouse Brake Co.	31
Westinghouse-Moroo Chain Co., Ltd.	9
Westwood, J., & Co., Ltd.	114
Wheeler Con. & Eng. Co.	117
Whitaker, D.	9
White, H. R. & Co.	128
White Jacoby & Co., Ltd.	117
White, Ed., & Sons	114
Wiggins, F., & Sons	119
Wigglesworth, F., & Co.	20
Wilson, H., & Co., Ld.	1
Winn, W. Martin & Co.	13
Wincott, G. F., Ltd.	140
Worthington-Simpson	98
Yarrow & Co., Ltd.	1 & 89
Yorkshire Copper Works, Ltd	6
Young, D. (Witney	140

15% FUEL ECONOMY

IS OBTAINED BY THE USE OF THE

EXHAUST STEAM INJECTOR

FOR BOILER FEEDING.

DAVIES & METCALFE, LTD.,

8479

ROMILEY, near Manchester.

Telegrams: "EXHAUST," ROMILEY. Telephone: 2219 STOCKPORT. Railway Address: ROMILEY, G. C. & M. Rly.

ROSS & DUNCAN.

MARINE ENGINEERS & BOILERMAKERS,

WHITEFIELD WORKS, GOVAN, GLASGOW.

ADMIRALTY CONTRACTORS.

TELEGRAMS: "WHITEFIELD, GLASGOW."

THE YORKSHIRE COPPER WORKS LTD.

Have Supplied Tubes for the following Dreadnoughts, viz.:—

LEEDS.

Codes:—"A.B.C." (4th and 5th Editions), Liebers, Scott, Western Union, Marconi International.

"Queen Mary," "Audacious," "Princess Royal," "Lion," "Monarch," "King George V," "Thunderer" "Orion," "Centurion," "Conqueror," "Benbow," "New Zealand," "Iron Duke," "Marlborough," "Tiger," "Delhi," "Queen Elizabeth." "Warspite," "Valiant."

COPPER, BRASS, **TUBES** CONDENSER TUBES.

8407

SOLE MAKERS OF **"BEMAL"** BRASS CONDENSER TUBES.

CONVEYOR AND ELEVATOR Co

J. J. STEVENSON,
PROPRIETOR.

BULL BRIDGE WORKS,
Accrington, Lancashire.

CONTRACTORS TO H.M. GOVERNMENT.

SPIRAL CONVEYORS.
COAL CONVEYORS.
GRAIN CONVEYORS.
TRAY CONVEYORS.

STOKEHOLD CONVEYORS.
GRAIN ELEVATORS.
COAL ELEVATORS.

CHAIN ELEVATORS.
BELT ELEVATORS.
DALE ELEVATORS.

Telegrams:
"Conveyor, Accrington."

National Telephone No. 2779.

8126

CAMMELL LAIRD & CO., LD., SHEFFIELD and BIRKENHEAD,

STEEL MANUFACTURERS. SHIPBUILDERS. ENGINEERS. 8478 BOILERMAKERS.

LONDON OFFICE: 3, Central Buildings, Westminster, S.W.

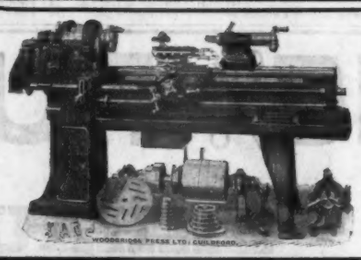
SEE LAST WEEK'S AND NEXT WEEK'S ADVERTISEMENTS.

THE DRUMMOND TOOLROOM LATHE

of definite Accuracy

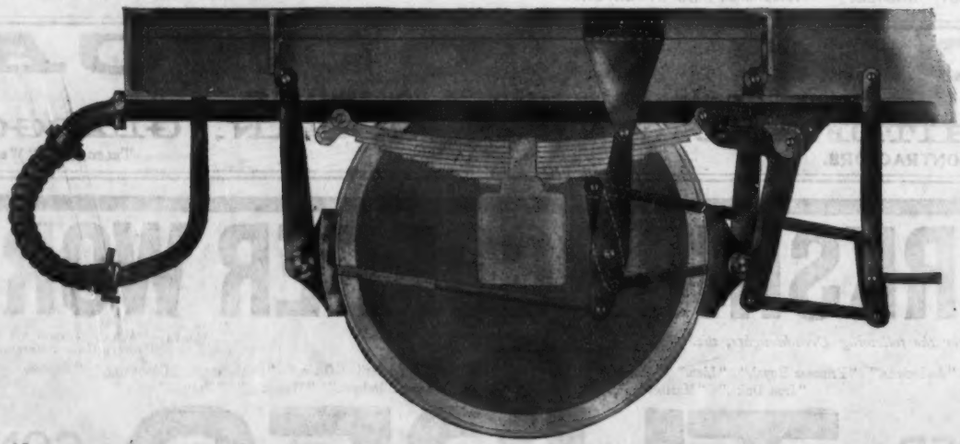
FOR IMMEDIATE DELIVERY.

DRUMMOND BROS. LTD., ENGLE WORKS, GUILDFORD.



VARIABLE BRAKE

The Brake Power varies AUTOMATICALLY in accordance with the Load Carried.



OVER 100% INCREASE IN BRAKE POWER ON THE LOADED VEHICLE.

THE CONSOLIDATED BRAKE & ENGINEERING CO., LTD.,

15, DEAN'S YARD, LONDON, S.W. 1.

TELEGRAMS:—"VACUO, VIC., LONDON." CODE:—ABC, 5TH EDITION. 8260 TELEPHONE:—VICTORIA 3987.

Telegraphic Addresses:—
"SIMONS, RENFREW."
"SIMONISM, LONDON."

Marine Dredge Plant

OF ALL DESCRIPTIONS AND UP TO THE HIGHEST CAPACITY.

Constructors of
HOPPER AND BARGE-LOADING BUCKET DREDGERS,
BARGE-LOADING, RECLAMATION AND "SIMONS" CUTTER SUCTION DREDGERS

Proprietors of ALFRED WATKINS' BRITISH PATENT for ROTARY SPUDS.

WM. SIMONS & CO., LTD.

"SIMONS"
PATENT
CUTTER
HOPPER
DREDGERS

Codes:—
A B C (5TH EDITION).
SCOTT'S (10TH EDITION).
BENTLEYS.

TRAILING SUCTION HOPPER DREDGERS.
GOLD AND TIN RECOVERY DREDGERS.
HOPPER BARGES.
FERRY STEAMERS.
REPLACE PARTS FOR EXISTING DREDGERS.
3135

INVENTORS AND FIRST CONSTRUCTORS OF "HOPPER" DREDGERS AND ELEVATING DECK FERRY STEAMERS.

LONDON OFFICE:—83, Victoria St.

RENFREW Near GLASGOW.

Manufacturers of Forgings of all kinds for Aircraft, Automobile and General Engineering Works.

Alloy and Carbon Steel in Bar or Billet, Bright Drawn Steel.

Weldless Steel Rings and Cylinders, Circular Blanks for Gears, Stampers' Die Blocks.

High Speed and Crucible Cast Steel for Engineers Taps, Dies, Punches, etc.

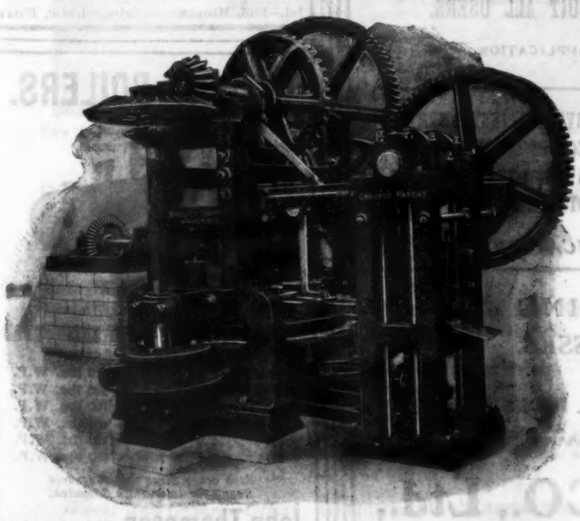
Best Cast Steel Files, Saws, Twist Drills, Hammers, Hack Saws, etc.

JOHN HOLDING & CO., LTD.,
Union Forge & Steel Works,
SHEFFIELD.

Telephones:
268 & 272.

8402

Telegrams:
"Holding, Sheffield."



No 1 "STIFF-PLASTIC" BRICK-MAKING MACHINE
Output 1000/1200 per hour.
We also build a larger Machine (No. 2 size) for 1800/2000 per hour. 06325

BRADLEY & CRAVEN, LTD.,

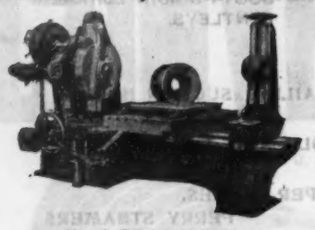
ESTABLISHED 1843. WAKEFIELD.

PIONEERS OF STIFF PLASTIC BRICK MAKING MACHINERY.

BRICKS PRODUCED BY OUR LATEST IMPROVED MACHINES ARE OF UNEQUALLED STRENGTH AND FINISH. READY FOR IMMEDIATE DELIVERY TO KILN.

HIGHEST OUTPUT — HIGHEST QUALITY.

H. W. KEARNS & Co., Ltd.
BROADHEATH, MANCHESTER.



No 3 SIZE MACHINE.

PATENT HIGH-SPEED 4815
SURFACING, BORING, MILLING & DRILLING MACHINES.

See our Illustrated Advert., page 109, June 11.

BEAUDRY HAMMERS

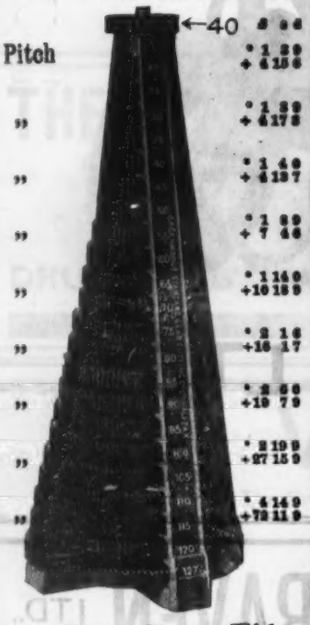
Belt or Motor Driven.
25 to 500 lb. Rams.
For General Forging.
Simple, Powerful, Durable.
Send for Catalogue.

BEAUDRY & CO., INC.
Boston, Mass., U.S.A.
Cable Address: "HAMMER" Boston. Lieber's Code.

AERIAL ROPEWAYS
TRANSPORTERS Ltd
CROWN HOUSE, KINGSWAY, LONDON W.C.2
ALL TYPES & SIZES

KITCHEN'S Patent REVERSING RUDDER
is superseding
REVERSE GEARS and REVERSING PROPELLERS
The propeller runs always in the ahead direction.
Particulars and Prices from— 8551
KITCHEN'S REVERSING RUDDER Co. Ltd.
747, Royal Liver Building, LIVERPOOL.
Telegrams— Reversing Liverpool. *Telephone—* 4116 Bank

CHANGE WHEELS — and — STANDS.
NETT PRICES for STANDS * 22 CHANGE WHEELS +



16 Pitch	*	1 10
	+	6 15 6
14 „	*	1 10
	+	6 17 6
12 „	*	1 4 0
	+	6 13 7
10 „	*	1 10
	+	7 4 6
8 „	*	1 14 0
	+	10 18 9
7 „	*	2 1 6
	+	15 1 7
6 „	*	2 6 6
	+	15 7 9
5 „	*	2 19 9
	+	27 15 9
4 „	*	4 14 9
	+	73 11 9

Keep Your Shop Tidy.

GEARS.
SPURS, BEVELS, SPIRAL, WORMS and RACKS, PAPER PINIONS & Screws.

CHANGE WHEELS
Accurately cut by new process.
Very low Prices—Ask for List.
Send your Enquiries. 8361

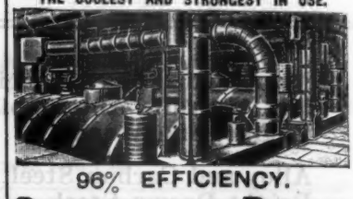
GREENWOODS STANDARD GEAR CUTTING CO., Ltd.,
NEW BOND STREET, HALIFAX.
Telephone 1212. Telegrams "Gears."

DEMPSTER, MOORE & CO., LTD
Engineers, GLASGOW.

From photo of 8½ in. Lathe. 8117
SPECIALITY:—NEW TYPE LATHES FOR HEAVY CUTTING.

OXY-ACETYLENE
WELDING AND CUTTING PLANT MANUFACTURERS.
COMPLETE EQUIPMENTS.
4896
McGOWAN, WILD & CO.,
Lower Hurst Street,
BIRMINGHAM.
Tel.—1816, MIDLAND. Teleg.—LOGIC, B'HAM.

CROWN BOILER COVERINGS
THE COOLEST AND STRONGEST IN USE.



96% EFFICIENCY.
SUTCLIFFE BROS.
Soho Works, Godley, near Manchester. Seal Wharf, Stratford, E, 15.

Drawing Office Equipment.
BRITISH MADE.

R.C. TRACING CLOTHS
ARE MADE IN FIVE QUALITIES TO SUIT ALL USERS.
SMALL SAMPLE ROLLS FREE ON APPLICATION.

No. 1. DRAWING INSTRUMENTS.	No. 5. SURVEYING INSTRUMENTS.
No. 2. SLIDE RULES, SCALES, &c.	No. 6. ELECTRIC COPIERS, &c.
No. 3. INKS, COLOURS, PENCILS, &c.	No. 7. DRAWING & TRACING PAPERS.
No. 4. DRAWING OFFICE FURNITURE	No. 8. PHOTO PRINTING.

CATALOGUE ON APPLICATION.

PHOTO PRINTING BY ALL PROCESSES. 8401

DRAWINGS AND TRACINGS REDUCED BY SPECIAL PROCESS FOR FILING.

B. J. HALL & CO., Ltd.,
CHALFONT HOUSE, GREAT PETER ST., WESTMINSTER, S.W.

STOCK BOILERS.

MOST MODERN "DISH END" TYPE
with Corrugated Sections.

Four	30' 0" × 9' 3" ×	120 lbs. W.P.
One	29' 6" × 8' 6" ×	120 lbs. W.P.
Six	28' 0" × 7' 6" ×	160 lbs. W.P.
Three	28' 0" × 7' 3" ×	160 lbs. W.P.
Five	24' 0" × 7' 3" ×	120 lbs. W.P.
One	22' 6" × 7' 3" ×	160 lbs. W.P.

Also other Sizes and Pressures Ready for Immediate Despatch.

John Thompson (Wolverhampton), Limited, 8121
WOLVERHAMPTON, Eng.

Westinghouse Morse

"A POWER SAVER FOR POWER USERS"

. . FOR . .

EFFICIENCY

RELIABILITY

SMOOTHNESS

. . AND . .

DURABILITY

WESTINGHOUSE MORSE

(ROCKER JOINT)

CHAIN DRIVES

8380

BEAT THE 'BAND.'

New Brochure Just Published,
May we send you a copy?

THE
WESTINGHOUSE MORSE
CHAIN COMPANY, LTD.
LETCHWORTH.
HERTS.

TELEPHONE: No. 33 LETCHWORTH. TELEGRAMS: CHAINDRIVE

HAVE YOU OUR LATEST CATALOGUE?

No vibration affects *these* mattresses!

PLUTO Blue Asbestos Mattresses, made of pure finely carded fibre, are double stitched with Asbestos twine to ensure their uniform thickness and close fitting under vibration. They are quickly applied, by means of hooks and lacing, being finally secured by iron bands. Removal is equally simple, owing to their pliability.

We have many stock sizes, generally 1in. to 3in. thick but make special mattresses any size, shape or thickness. We prepare these with all fittings on receipt of your drawing or blue print, and guarantee exact fitting. If desired, our men will do the fixing. To ensure absolute insulation, "Blue Jacket" Sectional covering, in 3 ft. lengths, should be used for steam pipes, &c., in conjunction with the mattresses. It is made of well teased Blue Asbestos fibre, is light, strong and easily removable. Outside finish can be either cotton canvas for exhaust pipes, or asbestos cloth for higher pressure. We provide planished or galvanized steel to cover all the lagging, in cases where a more uniform finish is required.

If you need laggings, packings, or any asbestos products, write us to-day, and we will forward actual samples of the kind we recommend, together with catalogue and Government Test Reports which bear out all we claim for Blue Cape Asbestos.

Showing the pliability of Blue Asbestos Mattresses.

7863

The Cape Asbestos Co Limited

Guildhall Annexe • 23 King Street • London E.C.

Factory, Barking, Essex

Actual Miners and Makers of Asbestos Products. *Tel.: City 598. Telegrams: Incorrupt, Cent, London.*

See our Stand No. 173, at the Great Victory Exhibition, Crystal Palace. Phone No. Sydenham 2518

"Richmond" Furnaces

Two "Richmond" Producer Gas-fired Continuous Wire-Annealing Furnaces each 50 ft. long, recently installed at a well-known Works.

Richmond's also manufacture Solid Fuel Furnaces for the processes of :—

Annealing Metals.	**Steel Frame Bending.**
Normalising and Hardening.	**Melting Metals.**
Case-Hardening.	**Enamelling.**
Plate Heating.	**Glass Annealing and Melting.**
Billet Heating.	**Firing Pottery, &c., &c.**

Supplied with either closed muffle or of the ordinary Oven type. Remarkably economical in coke consumption, a saving of from 25% to 30% being effected over direct-fired Furnaces.

RICHMOND FURNACES

(*The Richmond Gas Stove and Meter Co., Ltd.*), 2047

Works and General Offices: **Grappenhall, Warrington,**

Offices: 164-172, Queen Victoria Street, London, E.C.4.

GEORGE FLETCHER & Co. LTD.

DERBY.

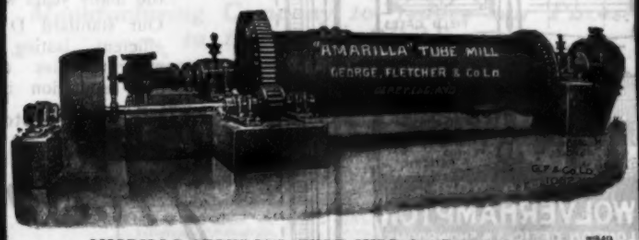
SPECIALISTS IN

COLLIERY, MINING AND CEMENT WORKS PLANT.

COMPLETE

CRUSHING & GRINDING PLANTS

FOR FERTILISERS AND BASIC SLAGS.



AMARILLA STANDARD TUBE MILL for Dry Grinding. 7349

Send us your Enquiries.

HALL PUMPS

FOR ALL CLASSES OF BOILER FEEDING, &c., &c.

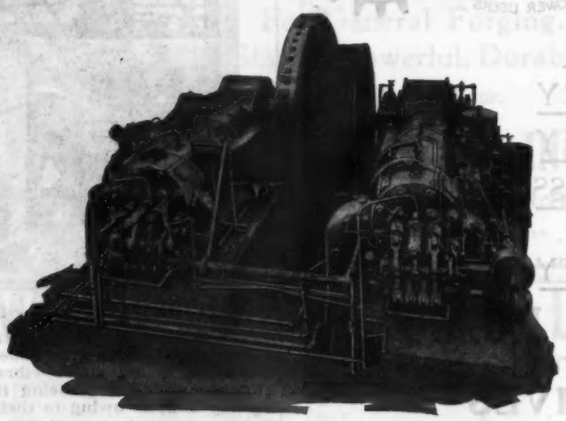
J. P. HALL & SONS, LD.
PETERBOROUGH.

THE
LEEDS ENGINEERING
AND
HYDRAULIC CO., Ltd.
RODLEY near LEEDS.

PUMPING &
HYDRAULIC
MACHINERY
Etc.

Telegrams: "PUMPS, RODLEY." REGISTERED TRADE MARK Code: ABC, 5th Edition.
Telephone: 160 STANNINGLEY. MARCONI INTERNATIONAL.

NATIONAL TRANSIT
PUMP AND MACHINE CO.,
OIL CITY, Penna, U.S.A.



150 HP. DIESEL OIL ENGINE.
Ready for immediate delivery.

Sole Export Representatives:—
CHURCH ST. MACHINERY & ENG. CORP.,
30, CHURCH STREET, NEW YORK, N.Y.

Cable Address: Cusmeco, New York.
Codes: A B C, Bentley's, Lieber's and Western Union.
7953

WATER TURBINES.
2 Units of 12,000 HP. made for VAMMAFOSSE
1 Unit ,, 16,400 HP. ,, RJUKANFOS
J. & A. JENSEN & DAHL, KRISTIANIA, NORWAY
Telegrams—MYREN, KRISTIANIA. 8110

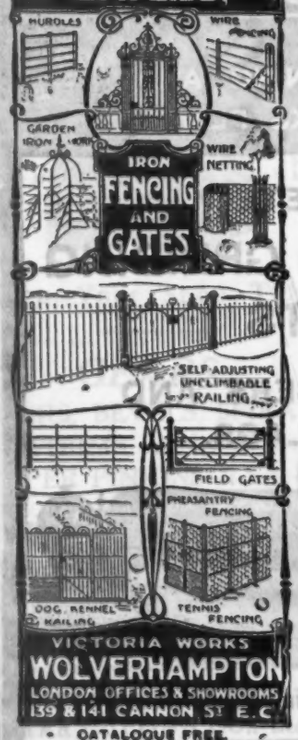
VALVES
REDUCING, SURPLUS, SAFETY, EMERGENCY STOP, &c. 5290
DAVID AULD & SONS, Limited,
WHITEVALE FOUNDRY, GLASGOW.
See displayed Advertisement, page 122, June 4.

REAMERS.

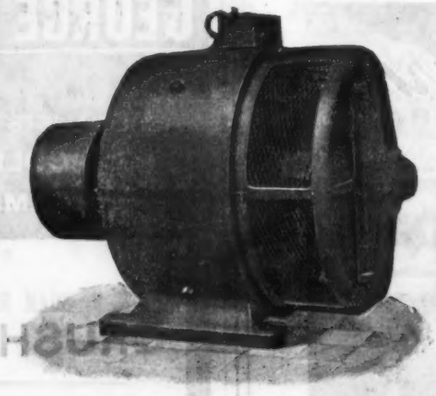
We can supply high class reamers of French Manufacture in inch or metric sizes, American type, at prices considerably below those practiced in England. 8653
Write us for specification.
CIE DES MOTEURS "NATIONAL,"
32, Rue des Mathurins, Paris.

CARELS DIESEL OIL
STEAM DROP VALVE or UNI-FLOW ENGINES
LONDON OFFICE
HEATH & SERENA
CARLTON HOUSE REGENT'S
WATERLOO PLACE, LONDON, S.W.1
Telephone Regent 3484.

BAYLISS, JONES AND BAYLISS, LTD.



VICTORIA WORKS
WOLVERHAMPTON
LONDON OFFICES & SHOWROOMS
139 & 141 CANNON ST. E.C.
CATALOGUE FREE.

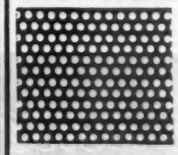


D.C. Electric Motors

The reputation of Castle Motors has been earned by their consistent performance under widely varying conditions during the many years we have been in business.
Our standard D.C. Motor—cool-running, efficient, lasting, reliable—is giving in all industries the service on which this reputation is based.

We make Motors from 1—700 HP.

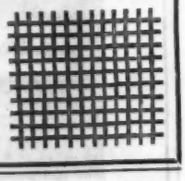
J. H. Holmes & Co
NEWCASTLE-ON-TYNE
Manufacturing · Electrical · Engineers



PERFORATED METALS.

G. A. HARVEY & Co. (London), Ld.
WOOLWICH ROAD,
LONDON, S.E. 7.
City Office—
SUFFOLK HOUSE,
LAURENCE POUNTNEY HILL, LONDON, E.C.4

WOVEN WIRE.



7976

7798

Hindley
Vertical
Multitubular
BOILERS

Satisfaction — and a small fuel bill.

WRITE
E. S. HINDLEY AND SONS,
11, Queen Victoria Street,
LONDON, E.C.4
'PHONE: 9804 CITY.

DING DONG MADE IN ENGLAND

PIONEERS OF THE ALL ENGLISH HACKSAW BLADE

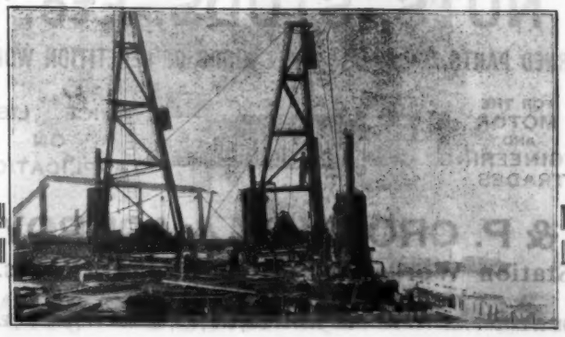
BEST QUALITY ALLOY STEEL HAND AND POWER BLADES BRANDED "DING-DONG" ARE MADE FROM A SPECIAL HIGH-GRADE SHEFFIELD STEEL, WHICH HAS BEEN FOUND PARTICULARLY SUITABLE FOR THE PURPOSE.

AFTER BEING HARDENED BY OUR OWN SPECIAL PROCESS, THE RESULT OF MANY YEARS' EXPERIENCE, THE BLADES ARE DRAWN TO A UNIFORM TEMPER. THE TEETH OF THE BLADES ARE MILLED IN SIX DIFFERENT DEGREES OF FINENESS FOR THE HAND BLADES, AND THREE IN THE CASE OF THE POWER BLADES, THUS PROVIDING FOR CUTTING ALL MATERIALS FROM SOLID BAR TO THE FINEST TUBING. 8819

"ASK YOUR DEALER TO SUPPLY THEM."

CHARLES BAYNES, Ltd., KNUZDEN BROOK, BLACKBURN.

Te'ephone No.: 6862. Telegraphic Address: HACKSAW, BLACKBURN.



Concrete in the Schools

THE other day the newspapers published photographs of school children having an object lesson in concrete construction. This shows the trend of the times. More interest is evinced in concrete nowadays than ever before, and it is well that the children should be made to realise its importance and the part it plays in modern commercial progress.

As experts with knowledge gained in all the fields of ferro-concrete and steel work construction we sometimes make claims that may seem a little bold. But we are prepared to back these claims with work actually done and proved in service, which after all, is the best evidence of any firm's efficiency. If you are contemplating the erection of Factory Buildings, ferro-concrete work, Steel work, please get in touch with us. We undertake all kinds of contracts, large or small, and guarantee the quality of the workmanship. 8384

D. G. Somerville & Co., Ltd.

120-122, VICTORIA ST., WESTMINSTER, S.W. 1.

BMT BMT BMT BMT

VULCAN

30-cwt. CHASSIS

1250 30-cwt. Vulcan Lorries have already been delivered to users this year.

100 VEHICLES PER WEEK

now being manufactured. Support British Labour and Industry. Over 1,000 ex-Service men engaged.

FIRST BENEFITS OF BRITISH MASS PRODUCTION

In spite of the continuous increases in the prices of raw materials and wages, the results of Mass Production now permit a reduction to the Buyer of a Vulcan 30-cwt. Commercial Vehicle Chassis of £75—*i.e.*, from

£750 to £675

Vulcan Agents throughout the British Isles will be pleased to book your orders for 30-cwt. Vulcan Chassis for early delivery at £675.

For utility, Service and Value the 30-cwt. Vulcan Lorry is unequalled in the World.

"ASK A VULCAN OWNER."

Thousands now in service as Tradesmen's Delivery Vans, Char-a-bancs, Station and Hotel Buses, Ambulances, Lorry-Tipping Wagons, Coal Wagons, Corporation and Public Service Vehicles.

MANUFACTURED BY VULCAN MOTOR & ENGINEERING CO. (1906), LTD., CROSSENS, SOUTHPORT.

THE LARGEST BRITISH COMMERCIAL VEHICLE MANUFACTURERS.

We are the First British Commercial Vehicle Manufacturing Company to reduce our Prices to the Buying Public.

SALES ORGANISATION—

BRITISH MOTOR TRADING CORPORATION LTD

DEPOTS: LONDON—90, 91 & 92, KING ST., ST. JAMES'S, S.W.1; MANCHESTER—250, Deansgate; BIRMINGHAM—Coventry Rd., Yardley; NEWCASTLE-ON-TYNE—St. Thomas Street; GLASGOW—British Motor Buildings (formerly Zoo), New City Rd.; where complete Specifications, Catalogues, and List of Agents can be obtained. PARIS—29, Rue de la Chaussée d'Antin.

HEAD OFFICE: 50, PALL MALL, LONDON, S.W. Telegrams: "Brimotrade, Charles, London." Telephone: Gerrard 8[illegible].

BMT BMT BMT BMT

St. James's 25.

SIEMENS (S M S Co Ltd) PROCESS
ESTD TRADE MARK 1872
"HALLSIDE"

CONTRACTORS TO—
BRITISH ADMIRALTY, WAR DEPT., and FOREIGN and COLONIAL GOVERNMENTS.

Manufacturers of—

MILD STEEL PLATES, ANGLES, Zed Bars, Tees and all forms of Sectional Bars required for Ship, Boiler, and Bridge Building, and other constructive purposes.

CASTINGS of all kinds and largest sizes for Ship Stems, Sterns, Posts, Anchors, Rudders, &c.

RAILS, BILLETS, FORGINGS.

AXLES of highest quality, to meet the requirements of Home and Colonial Railways.

TYRES.—Locomotive Carriage and Wagon, to all requirements.

SPECIAL STEEL of all kinds for constructive purposes.

THE . . .

STEEL COMPANY of SCOTLAND LIMITED.

23, ROYAL EXCHANGE SQUARE, GLASGOW.

TELEGRAPH ADDRESS "STEEL" GLASGOW.

8314

CRADOCK'S ROPES

ARE MANUFACTURED ONLY FROM THE HIGHEST CLASS BASE OF

ENGLISH HAEMATITE AND SWEDISH CHARCOAL PIG IRON } Converted into STEEL at CRADOCK'S OWN WORKS.

And SUPPLIED IN THE FOLLOWING GRADES— 3833

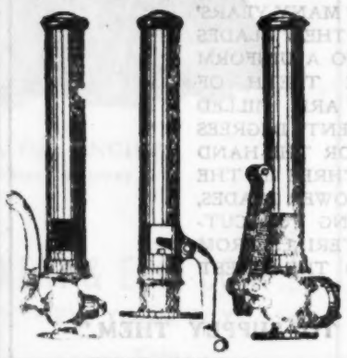
Guaranteed Swedish Base—Special Acid.
Guaranteed Special Acid, Guaranteed Acid.

CRADOCKS ALSO SUPPLY ROPES MADE FROM

Guaranteed English Basic } This Material is Purchased in the Billet and subsequently manufactured at their Works.
In one Grade only, viz., 70/90 tons sq. in.

GEORGE CRADOCK & CO., LTD., WAKEFIELD.

FRANCE & MORGAN,



MAKERS OF EVERY DESCRIPTION OF

Brass Work

USED BY

MARINE ENGINEERS.

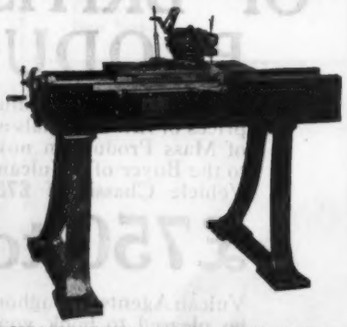
WHITEFIELD BRASS WORKS,

GOVAN, GLASGOW. 8788

SIP

DIVIDING MACHINES

for INDUSTRIAL and COMMERCIAL PURPOSES.



LONGITUDINAL DIVIDING MACHINES
(British or Metric Units).
CAPACITIES: 20 to 40 INCHES.
Accuracy guaranteed.

CIRCULAR DIVIDING MACHINES
UP TO 80 INCHES TABLE DIAMETER.
ALSO
Measuring Machines, Precision Lathes, Limit and Screw Gauges, Bench Micrometers.

SOCIÉTÉ GENEVOISE D'INSTRUMENTS DE PHYSIQUE,
96, QUEEN VICTORIA STREET, LONDON, E.C. 4. 8684

BRIGHT STEEL BOLTS, NUTS, STUDS, Etc.

TURNED PARTS. ALL KINDS OF REPETITION WORK.

FOR THE MOTOR AND ENGINEERING TRADES.

PRICE LISTS ON APPLICATION

8680

H. & P. CROSSLEY & ACKROYD,
Station Works, MYTHOLMROYD, Yorks.
Telegrams: "Precision, Mytholmroyd."
LONDON & EXPORT AGENTS: SHEFFIELD SUPPLY CO., LTD., 103, CANNON ST., LONDON, E.C. 4.

ROPE DRIVING

FOR EFFICIENCY & DURABILITY USE

Illustrated Lecture on—
"THE TRANSMISSION OF POWER BY ROPES."
Post Free on Application.

Telegrams: Kenyon, Dukinfield.
Telephone: 494, Ashton.

LONDON OFFICE:
95 & 97, FINSBURY PAVEMENT, E.C.

2911

WM. KENYON & SONS, LTD.
CHAPEL FIELD WORKS,
DUKINFIELD, Near MANCHESTER.

HOSE

CAUTION. £50 REWARD.

HOSE Merryweather and Sons, Hereby CAUTION all Colonial and Foreign Buyers of their "Extra Dub-Sub," "Dub-Sub," and other brands of Fire Hose, to see that their name as well as the distinctive brand appear on each length. Don't accept Hose Substance" only; marked "Double is upon each length. £50 reward will be paid for information leading to the conviction of any person pirating any of Merryweather & Sons' Registered Trade Marks.

Greenwich, S.E 10, and 63, Long Acre, London, W.C. 2.

VISITORS INVITED TO INSPECT HOSE IN COURSE OF MANUFACTURE.

HOSE

Write for Pamphlet "Hints on Hose," No. 50. 63, Long Acre, London, W.C. 2. 8277

Telegrams: "Galloway, Manchester."

GALLOWAYS
LIMITED
MANCHESTER.

'Phone: 6312 Central.

ENGINES

UNIFLOW

PISTON DROP VALVE

ROLLING MILL

PUMPING

LARGE GAS ENGINES

PATENT UNIFLOW ENGINE.

8372

BOILERS

MODERN DESIGN

INCREASED HEATING SURFACE

LARGE COAL SAVING

HIGHEST EFFICIENCY

The Uniflow Steam Engine represents the most modern and highly efficient type of prime mover.

ESTB 1907.

W. MARTIN WINN & Co.
STATION WORKS.
DARLASTON.

BRIGHT DRAWN STEEL BARS HEX. SQUARE & ROUND.

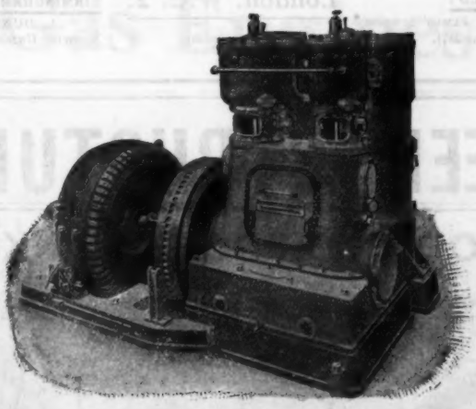
BRIGHT STEEL BOLTS & NUTS STUDS, SET PINS ETC.

PHONE 73.

TELEGRAMS "ACCURACY"

WALKER BROS. (WIGAN),
LIMITED,

Codes: A B C 4th and 5th, Lieber's, Western Union, Moreing & Neal, Mining.



AIR COMPRESSORS

with light Disc Valves to recent Patents now at work (or on order) indicating over

150,000 raising total output to **520,000 H.P.**

PATENT UNLOADING DEVICE AND OUTPUT REGULATOR, FOR POWER DRIVEN PLANTS.

Ventilating, Winding and General Mining Machinery. 7481

Pagefield Ironworks, WIGAN.

Telegraphic Address: "Pagefield, Wigan." Telephone No. 14 Wigan (2 lines).

If you are looking out for

Standard Sizes 6 to 50 Gallons.

the PERFECT SYSTEM of storing ALL KINDS of Oil for daily use, you cannot do better than instal

"VALOR" Oil Cabinets.

No Waste. No Leakage. No Smell.

CAPACITY - -	50	30	20	12	6	gallons.
PRICES, including Crates	95/-	80/-	70/-	60/-	50/-	each.

For use in Factories, &c., and Establishments where cleanliness and safety are considered.

The Valor Company, Limited,
Aston Cross, BIRMINGHAM.

Ashmore, Benson, Pease & Co.,

LIMITED,

STOCKTON-ON-TEES.

Makers and Erectors of

BLAST FURNACE PLANT,

GAS CLEANING PLANTS,

STEEL FURNACES, PRODUCERS, &c.

COAL, COKE & ORE BUNKERS.

Cast Iron and Steel Work
for Coke Ovens and Chemical Plants.

GAS WORKS PLANT OF EVERY DESCRIPTION.

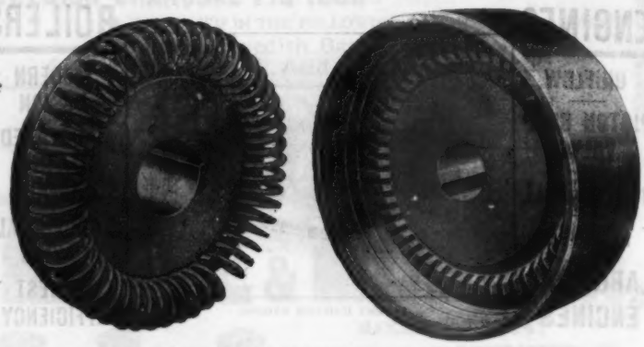
CASTINGS UP TO 20 TONS.

SOLE MAKERS OF

Forter's Patent Reversing Valves

For Steel, Glass and other Furnaces. 8227

FLEXIBLE SHAFT COUPLINGS.



"UNION" PATENT FLEXIBLE SHAFT COUPLING.

These Couplings are suitable for all kinds of drives and are being successfully used in many rolling mills where the nature of the drive is very severe.

ELECTRO-METALS, LTD.,

MANCHESTER:
R. MILLETT,
30, CROSS STREET.
(City 7772).

SHEFFIELD:
19, ST. JAMES' STREET.
(Central 257).

HEAD OFFICE:
56, Kingsway,
London, W.C. 2.
(Holborn 6430).

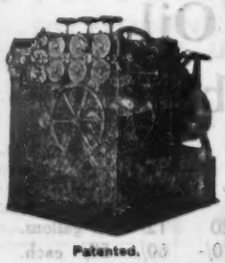
NEWCASTLE-ON-TYNE:
J. R. STRAKER-WILSON,
3, ST. NICHOLAS BUILDINGS.
(Central 2749).

BIRMINGHAM: 7872
L. DUNKER,
NORWICH UNION BUILDINGS.

SPRING COILING
— AND —
WIRE COILING MACH'Y

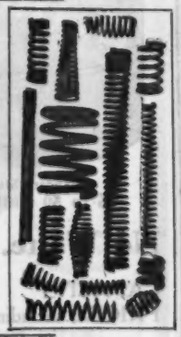
of every description and for every purpose.

For instance, our UNIVERSAL SPRING COILERS (built in eight sizes, to handle oil-tempered wire from ·004 in. diam. to $\frac{5}{8}$ in. diam.) will produce, without requiring any other equipment than that furnished with each machine, any or all of the spring forms illustrated herewith.



Patented.

We offer to— THE **PROFESSIONAL SPRING MAKER** more than **FORTY STANDARD MACHINES** and numerous special ones. 7p1



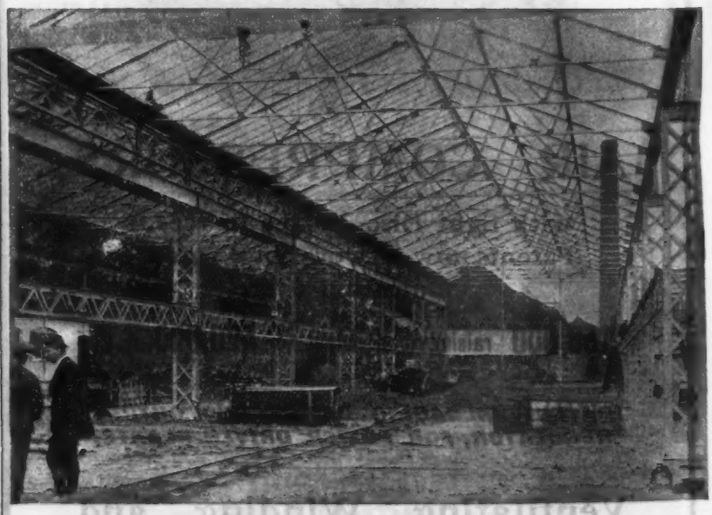
SLEEPER & HARTLEY, INC. WORCESTER, Mass., U.S.A.

AGENTS AND REPRESENTATIVES.

U.K.: F. A. PERRY, 68, Queen Victoria Street, London, E.C. 4.
France, Belgium and Switzerland: EDGAR BLOXHAM, 12, Rue du Delta, Paris.
Italy: H. COE & CLERICI, Milan. Australia: EDWIN WOOD PTY, Ltd., Melbourne.
South Africa, New Zealand, India, China, Japan, South and Central America, and Mexico: AMERICAN STEEL EXPORT CO. OF NEW YORK.

STEEL STRUCTURES

ROOFS, BRIDGES, TANKS.



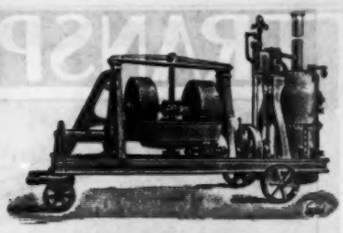
CLYDE STRUCTURAL IRON Co., Ld.

CLYDESIDE IRON WORKS, 6603

Telegrams:
CORRUGATED, GLASGOW.

Telephones
WESTERN 2952-2953

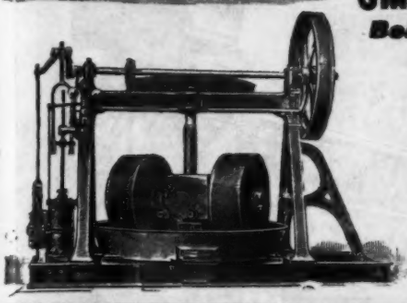
SCOTSTOUN, GLASGOW.

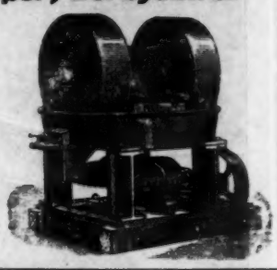


GRINDING MILLS.

SMEDLEY BROS., LTD.

Belper, Derbyshire. 7603





(TRADE MARK.)

"TEXO"

DEPENDABLE ENGLISH OAK-TANNED

LEATHER BELTING

FOR

HEAVY MACHINE TOOLS,

MAIN DRIVES

AND

TEXTILE MACHINERY.

HYDRAULIC LEATHERS.

OIL DRESSED VALVE HIDES.

RAW-HIDE MALLETS, HIDE-FACED HAMMERS.

"PLEXUS" ROUND GUT MACHINE BANDING.

All kinds of Technical Leathers used in Mining, Engineering, Shipbuilding, Iron and Steel Making and Textile Trades.

E. J. COOKE, TRINITY LEATHER WORKS, BLACKFRIARS, MANCHESTER. 8813

Telegrams: "HIDES, MANCHESTER" Telephone: CENTRAL 1544

Browett-Lindley

Gas Engines

Above we show a view of our Patricroft Works—the home of the well-known Browett-Lindley Gas Engines. These Engines have gained a high reputation by their sterling qualities. Simply designed and soundly constructed with liberal bearing surfaces, they insure the maximum economy. Power is equally distributed in each cylinder and back-fire is absolutely avoided.

BROWETT, LINDLEY & CO., Ltd.
Sandon Works,
PATRICROFT, Manchester.
LONDON OFFICE: Amberley House, Norfolk St.
GLASGOW OFFICE: Sandon, Westerton, N.B.

Send for our List of Users — it contains the names of some of the largest firms in the country.

6426

VERTICAL HIGH SPEED

ENCLOSED STEAM ENGINES

Simple & Compound.

Briefly the outstanding advantages of these engines are:—Substantial construction, Governor enclosed in crank case, Convenient Oil Pressure Regulation, Patent Duplex Reversible Strainer, which can be cleaned while running. They are suitable for direct coupling to Dynamos, Fans, Pumps, etc., and are silent, economical and reliable. For ship lighting and industrial works of all kinds.

E. S. Hindley & Sons

11, QUEEN VICTORIA ST. LONDON : : : : : E.C. 4.

Telephone 9804 City (2 Lines). | Telegraph Steamport, Cannon, London.

WORKS BOURTON DORSET.

6831

4 to 300 H.P.

Wakefield Patent

MECHANICAL LUBRICATOR

For **Saturated and Superheated Steam, Gas & Oil Engines, Air Compressors, &c.**

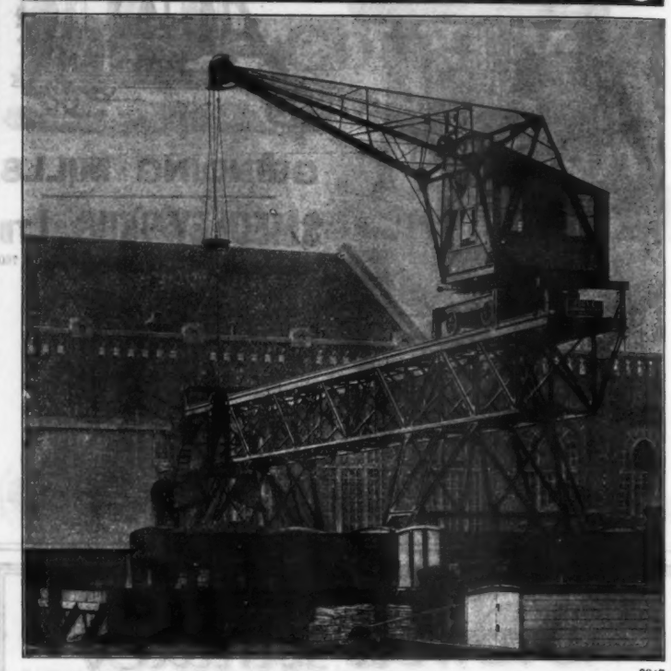
Nearly **22,000** ENGINES NOW FITTED WITH WAKEFIELD LUBRICATORS.

7618

C. C. WAKEFIELD & CO., Ltd.,

Wakefield House, Cheapside, London, E.C. 2.

TRANSPORTERS



8347

FIGEE LTD. HAARLEM HOLLAND

SOLE BRITISH AGENT: B. J. ALLISON

53, NEW BROAD STREET, LONDON, E.C. 2.

Tele: "Soundings, 'Phone. London." Phone: London Wall 1137. Code: A B C (5th Edition).

ANYTHING worth doing is worth doing well.

If you are installing a lubricator instal a

MOLLERUP LUBRICATOR

AND SEE IT'S MADE BY

HUNT & MITTON, Ld.

OOZELLS STREET NORTH,

BIRMINGHAM.

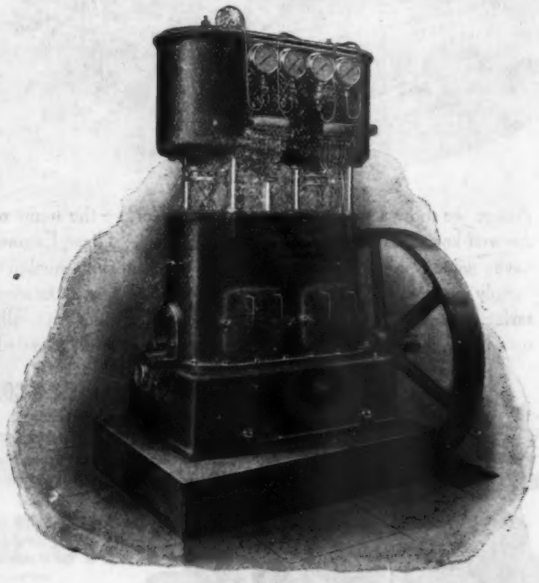
8266

Telegrams :: :: Mitton, Birmingham,
Telephone :: :: 393 and 394 Midland.

FOUR STAGE

COMPRESSORS

FOR COMPRESSION AND LIQUEFACTION OF GASES.



SEAGERS, LD.,

DARTFORD.

8077

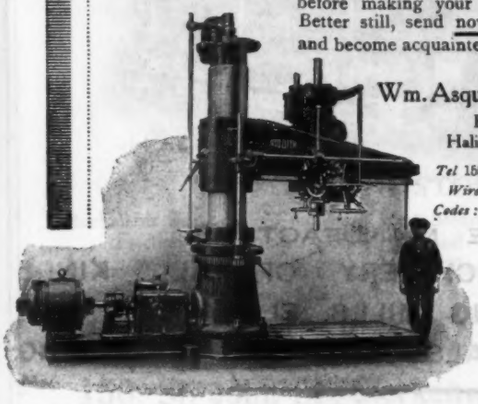
DRILLING MACHINES.

Merits that appeal.

"Asquith" Radials are well-known and approved in all branches of Engineering industry. They have established a reputation in a wide field—and they maintain it! This is the direct result of over 20 years' quality manufacturing.

ASQUITH

radials are held in high esteem by discriminating buyers of machine tools. That is why you should thoroughly understand what "Asquith" means before making your final decisions. Better still, send now for catalogue and become acquainted.



Wm. Asquith (1919) Ltd.
Park Works,
Halifax, England.

Tel 1558 *Halifax* (4 *lines*).
Wire: Drill, Halifax.
Codes: A B C 5*th Ed. and Lieber's.*

MEMBERS OF:
The Associated British Machine Tool Makers, Ltd.,
17, Grosvenor Gdns., London, S.W. 1, and Branches.

4208

PAISLEYS
BOILER SUITS

are celebrated throughout Great Britain and known to Engineers over the whole world. A SPECIAL SUIT much in favour with Boiler Inspectors, has been supplied by us to many of the leading Insurance Companies in Scotland and England.

INSPECTORS BOILER SUITS, to measure in Drabette and Drab Jean, Double Knees and Elbows ...	25/-, 27/6, 33/- per suit.
Ordinary Stock Sizes, Ready Made ...	21/- per suit.
Ditto Double Knees and Elbows	23/6, 25/- per suit.
ORDINARY BOILER SUITS, buttoned straight down front, detachable buttons, in Blue Dongaree ...	14/6, 16/6 per suit.
Ditto in Brown Denim ...	12/6, 14/6, 16/6 per suit.
BROWN GOVERNMENT JEAN BOILER SUITS	13/6 per suit.
WHITE BOILER SUITS	15/6 per suit.
KHAKI BOILER SUITS	14/6, 17/6 per suit.
BOILER SUITS TO MEASURE, 2/6 EXTRA,	
GOVERNMENT JEAN JACKET AND BIB TROUSERS	10/6 per suit.
BROWN DRILL JACKETS	7/6, 9/- each.
BROWN DRILL OVERALL TROUSERS (American shape)	8/9, 10/6 per pair.
BLUE DONGAREE JACKETS	6/9, 8/- each.
BLUE DONGAREE BIB TROUSERS...	7/9, 10/6 per pair.
KHAKI ST. CRISPIN COATS ...	13/6, 15/6, 19/6, 22/-
BLUE ST. CRISPIN COATS	13/9, 18/6
KHAKI AND BLUE COATS, three-quarter Length	13/-

LADIES' OFFICE OVERALLS in Great Variety.

Postage—Purchases over 10/- *Carriage Paid in the United Kingdom.* 6735

INSPECTOR'S SUIT.

Instructions for Self-measurement.

	Ins.
Length from centre of back to wrist (arm slightly bent)	
Length of arm (inside)	
Length from fork to bottom of leg (inside measurement)	
Length from armpit to bottom of trousers	
Width round chest	
Width round waist	
Width round seat	
Width round thigh	
Width round bottom of leg...	

Please give height—
.....ft. .....ins.

Illustrated List Free by Post

PAISLEYS Ltd.,
72/96, Jamaica St., GLASGOW.

THE HORSELEY BRIDGE AND ENGINEERING CO., LTD.

Builders of Bridges & Piers,

VIADUCTS, ROOFS, CRANES, STEEL TANKS.

CONSTRUCTIONAL WORK OF ALL DESCRIPTIONS, AND PRESSED STEEL FLOORING.

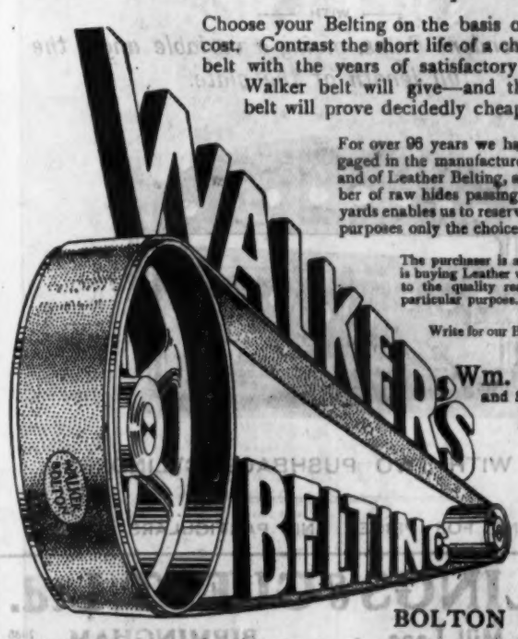
4206

HEAD OFFICE & WORKS:
TIPTON, STAFFORDSHIRE.
LONDON OFFICE:
11, VICTORIA STREET, WESTMINSTER, S.W. 1.

From Pelt to Belt

There is a Walker belt for every drive—tanned, curried and manufactured at our works—which has rightly earned the reputation of being the belt that does all it is intended to do—and keeps on doing it.

Choose your Belting on the basis of ultimate cost. Contrast the short life of a cheap-to-buy belt with the years of satisfactory service a Walker belt will give—and the Walker belt will prove decidedly cheaper to use.



For over 96 years we have been engaged in the manufacture of Leather and of Leather Belting, and the number of raw hides passing through our yards enables us to reserve for Belting purposes only the choicest selections.

The purchaser is assured that he is buying Leather which conforms to the quality required for his particular purpose.

Write for our Belting Booklet.

Wm. Walker
and Sons Ltd.
Bolton
Lancs.
Eng.

7888

BOLTON

G1

SMOOTH-ON

TRADE MARK REG. U.S. PAT. OFF.

IRON CEMENTS

Make permanent repairs of steam, water or oil leaks on iron and steel castings, boilers, engines, tanks, etc.

Every Engineer and Foundryman should have a copy of our new 144 page illustrated Instruction Book. It is free.

WALTER P. NOTCUTT, LTD..
8, White Street, Moorfields, London, E.C.

Large stocks on hand ready for immediate delivery by

LONDON. Messrs. F. A. PULLEN & CO., 58, Harleyford Road, Vauxhall, S.E. 11.
BUCK & HICKMAN, Ltd., 24, Whitechapel Road, E.
Messrs. C LINDLEY & CO., LTD., 34, Englefield Road, N.
LIVERPOOL. Mr. JOHN TAYLOR, 10, Strand Street.
MANCHESTER. THE WALMSLEY ENGINEERS' SUPPLY CO., 23, King Street West.
A. DAWES & SONS, Ltd., 181, London Road.
J. P. MOFFATT, 454½, Aniaby Road.
A. E. SMITHSON & CO., West Bute Street. 05108
ANDREW McLEAN & CO., 109, Main Street, Bridgeton.

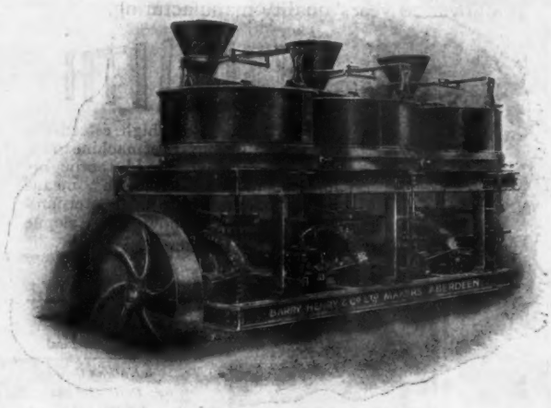
BEWARE OF IMITATIONS.

Send for New
No.16 Illustrated Instruction Book

BARRY, HENRY & Co. LTD.

ENGINEERS & FOUNDERS.

London Office:
155, FENCHURCH ST., E.C. 3. **ABERDEEN.**



WE MANUFACTURE
MILLING MACHINERY OF ALL KINDS
GRINDING MILLS, ELEVATORS, 7888
CONVEYORS, ALSO SHAFTING & GEARING.

WIRE "BARRY" OR PHONE 333 ABERDEEN.

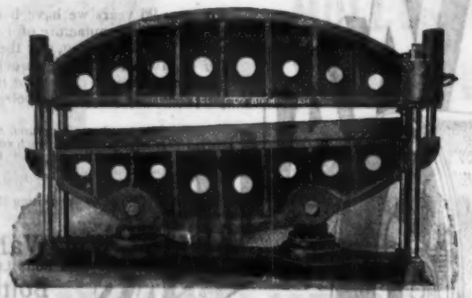
TO SHIPBUILDERS.

NEW DESIGN OF LARGE HYDRAULIC

KEEL PLATE FLANGING PRESS

— WITH —

Two Independent Rams, giving a variable angle the full length of the plate.



FITTED WITH TWO PUSHBACK CYLINDERS.

SEND FOR PRICES AND PARTICULARS.

HOLLINGS & GUEST, Ltd.

Thimble Mill Lane - - - BIRMINGHAM. 7965

BOILERS

Yorkshire
Lancashire
Cornish
Multitubular
Vertical

A Yorkshire Boiler 24 ft. long will give the same evaporation for 9 cwts. of coal as a 30 ft. Lancashire will give for 10 cwts. This equals a saving of 100 tons of Coal per boiler per year.

HOLDSWORTH & SONS, LTD.,

With which is incorporated The Yorkshire Boiler Co., Ltd.,

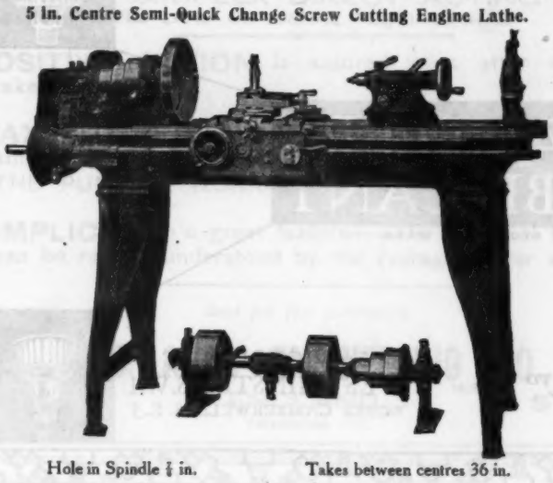
CROFT BOILER WORKS,
LEEDS ROAD,
BRADFORD. 8363

LONDON OFFICE: 34, Victoria Street, Westminster, S.W. 1.
SOUTH WALES: Gordon Chambers, Queen Street, Cardiff.
SHEFFIELD OFFICE: Prudential Buildings, Pinstone Street.

- - THE NEW - -

SHEPARD LATHE.

5 in. Centre Semi-Quick Change Screw Cutting Engine Lathe.



Hole in Spindle ⅞ in. Takes between centres 36 in.

IN LONDON STOCK

Attachments included :—Compound Rest, Steady Rest, Face Plate, Friction Countershaft, Gear Guards and Wrenches.

Attachments extra : —Milling, Metric, Taper, Turret, Draw-in, Motor and Foot motion. 8308

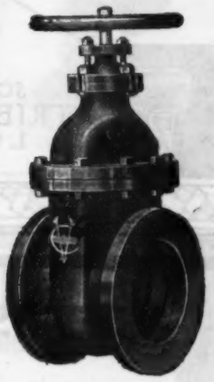
FARMER & COMPANY

150, St. John St., Clerkenwell, E.C. 1.

Telephones :—City 3470 (7 lines). Telegrams : LOCKSTONE, SMITH-LONDON.

CROSBY

SIGHT FEED LUBRICATORS.



CHAPMAN

GATE VALVES

with parallel gates or wedge plug.

HIGH-TEST PRESSURES.

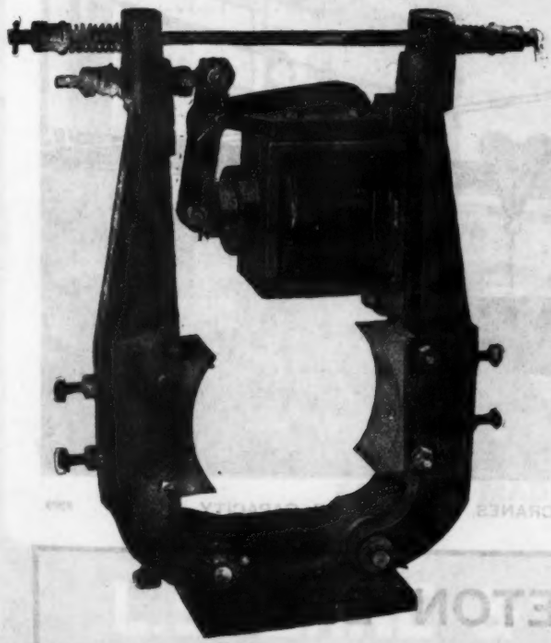
High-class Valves and Fittings will outlast cheaper makes and give better results.

Crosby Valve & Engineering Co., Ltd.,

147, Queen Victoria St., London, E.C. 710

ELECTRO-MECHANICAL

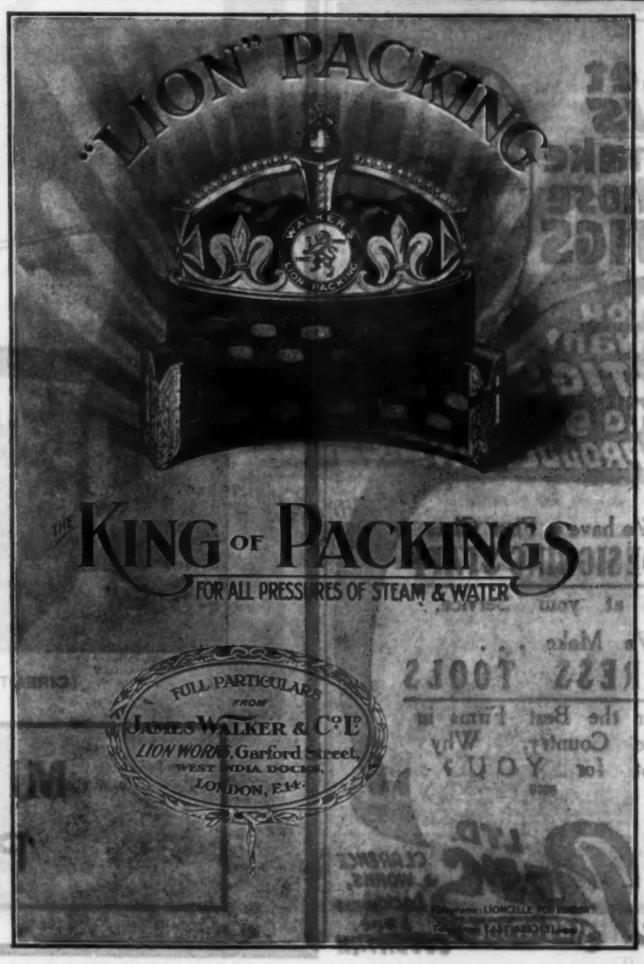
BRAKES.



ELLISTON, EVANS & JACKSON, LTD.

18, CROSS STREET, FINSBURY, E.C. 2. 8035

Telephones : Clerkenwell 1924 & 1925. Telegrams : "Elevanja, Finsquare, London."



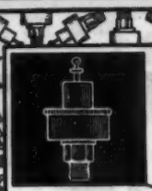
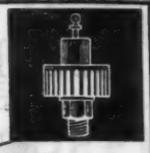
CHARGING MACHINES,
FURNACES, MIXERS,
GAS PRODUCERS,
CRANES, TRANSPORTERS,
STACKING HOISTS.

The WELLMAN SMITH OWEN ENG. CORP. Limited,
King's House, Kingsway, London, W.C. 2.
Works: Darlaston, South Staffs.
Telephone— Holborn 1784 & 2898. Darlaston 67 (3 lines).
Telegrams— Principium, We toast, London. Enjasmits, Darlaston.
8027
See display Advt. on page 24, issue of June 18.

FRANK
WIGGLESWORTH
& Co. LTD
SHIPLEY
FRICTION CLUTCHES
SHAFTING GEARING
BELT & ROPE PULLEYS

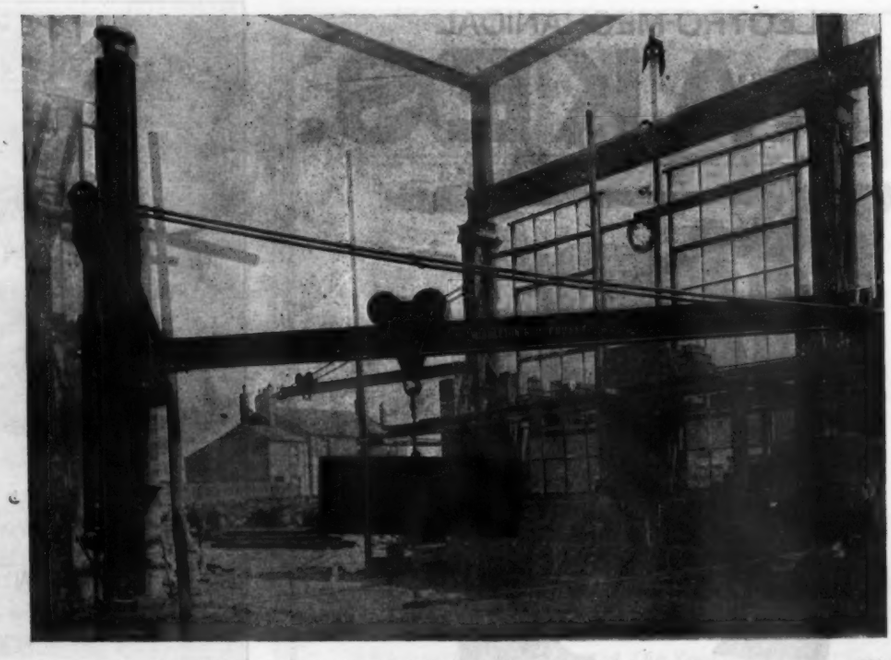
THE
CLEVELAND
BRIDGE AND
ENGINEERING CO., LTD.
8021
Specialists in the Design, Manufacture, and Erection of Bridges, Girders, Roofs, Warehouses, and all Classes of Iron and Steel Constructional Work.
HEAD OFFICE AND WORKS—
DARLINGTON.

We have a First Class
DESIGNING STAFF
at your Service.
We Make . . .
PRESS TOOLS
for the Best Firms in the Country. Why not for YOU?
8573
LTD. Parr JIGS & TOOLS
CLARENCE WORKS, Lockhurst Lane, COVENTRY


THE STANDARD MACHINE GREASE
FIRST IN 1882
FOREMOST EVER SINCE

STAUFFER'S LUBRICANT
REG. TRADE MARK

SOLE MAKERS
TRIER BROS. LTD
LONDON
8004
36 VICTORIA ST
WESTMINSTER S.W.1
WORKS CAMBERWELL S.E.5

HYDRAULIC CRANES
FOR
SHIPYARD SERVICE.



DIRECT LIFT JIB CRANES. 3 & 5 TONS CAPACITY.
8239

MIDDLETON BROS.,
PUDSEY, YORKS.

"MOORLANDS" PUMPS.

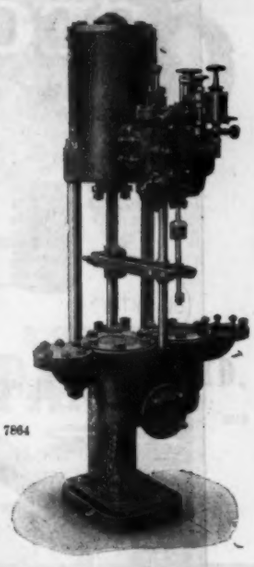
PATENT SIMPLEX DIRECT ACTING TYPE
FOR LAND OR MARINE REQUIREMENTS.

POSITIVE ACTION is assured even after wear has taken place.

MAXIMUM ECONOMY is obtained owing to being able to regulate the cut-off in the Steam Cylinder WHILE THE PUMP IS WORKING, to suit any duty.

SIMPLICITY is a great feature——The action of the Pump can be readily understood by the average Boiler attendant.

Send for full particulars.


7864

THE MOORLANDS ENGINEERING CO., LTD.,
LEEK, ENGLAND. STAFFS,
Telephone 101.

ECONOMICAL GRINDING.

8069

EMERY WHEELS
AND
GRINDING MACHINES.
BRITISH MADE.

L. STERNE & CO., LTD.,
THE CROWN IRON WORKS, GLASGOW.
LONDON OFFICE: DONINGTON HOUSE, NORFOLK ST. W.C.

WELLS' INCANDESCENT OIL LAMP.

IMPROVED PATTERNS.

A Cheap, Brilliant, and Shadowless Light from Paraffin or Petroleum. For Inside and Outside Lighting.

Stormproof, Simple and Economical.

300 to 1000 CP.

With Removable Vaporiser, quickly detached and readily cleaned, without displacing globe or mantle.

WELLS' "LIGHTNING" PAINTER.

(Wallwork & Wells' Patents.)

PAINTING BY MACHINE.

GREAT SAVING IN TIME, PAINT AND LABOUR.

OVER 700 SOLD.

PAINTING SPEED—3 sq. yds. a minute.

The paint is sprayed evenly and continuously through a flexible tube and nozzle, supplied with compressed air, either from existing air main or from our special compressors.

KETTLE TORCH LAMPS.

THE MINER'S FAVOURITE.
THOUSANDS SOLD.

Used exclusively by De Beers, Randt Mines, etc.

Also largely used by Contractors, Corporations, Collieries, etc.

LARGE FLAMING LIGHT.

WELLS' TORCH LAMPS.

For Sperm, Rape, Colza, or other heavy Smokeless Oil. Also used for Kerosene.

No. 5, ½ pint, Hook No. 3.
No. 5a, ¾ pint, Hook No. 3.
No. 6a, 1 pint, Hook No. 3.

WELLS' Removable Bung-Pour.

8442

Also made in GUNMETAL.
For Emptying Cask without Pump, Tap, or Stillage.

Applied to and removed from any cask instantly. All waste and mess prevented. More rapid in action than a pump. Will fill any ordinary cask from 10 to 60 gallons.

A. C. Wells & Co. 102 Midland Rd., London ST. PANCRAS, N.W. 1.
Works: Carnarvon St., MANCHESTER.

KENYON'S PATENT OIL FILTER AND WATER SEPARATOR.

Over 900 ordered by H.M. Government.

ENGINEERS' STORES TOOLS.

ALEXANDER KENYON & CO., LTD.,
Victoria Bridge, MANCHESTER. 8006

STAMPINGS

ANY WEIGHT. 8487
IN ANY STEEL.
FOR ALL PURPOSES.

HEAVY STAMPINGS LTD.,
MIDDLESBROUGH.
TELEGRAMS—STAMPINGS. TELEPHONE—201.
LONDON OFFICE: 71, Southwark Street, S.E.1
TELEPHONE—Hop. 5217 (3 lines.)

Governors

(PICKERING TYPE), and with
"SMITHS" PATENT KNOCK-OFF GEAR
Simple. Efficient.
Jockey Pulley abandoned
Operates should Governor stop from any cause.

Sole Licensees and Makers:
Pollock, Macnab & Highgate
SHETTLESTON, 7103
GLASGOW.
Makers to War Office and Admiralty.

G. & A. HARVEY, LTD.

GOVAN, GLASGOW, W.

MAKERS OF
HIGH-CLASS MACHINE TOOLS.

PROMPT DELIVERY. 8229
CATALOGUE ON APPLICATION.

See our Illustrated Advt. in next week's issue.

R. B. LINDSAY & Co
38 MAIR ST
PARTICK
GLASGOW

FOR ALL STEAM PRESSURES
TEL. CONICAL GLASGOW

PATENT CONICAL ENGINE PACKING

CALVANISED CORRUGATED SHEETS.
MERCURY BRAND.
(BEST AND CHEAPEST.)

Send us your enquiries. Thick gauges and all difficult Corrugations as used for—
COLLIERIES, CONSTRUCTIONAL ENGINEERS,
A Speciality. Also Galvanised Ridges, Louvre Blades, Riveted Galvanised Pipes for Colliery Ventilator Shafts, &c., &c.

RAMSHAY & MARSHALL, Ltd.
BIRMINGHAM. 4156

GEO. SALTER & Co.

LIMITED

Manufacturers Of All Kinds Of
STEEL SPRINGS FOR ENGINEERING USE
STEAM GAUGES, LOCOMOTIVE BALANCES
TUBE SCRAPERS &c

Contractors to WAR OFFICE And ADMIRALTY.
Foreign & Colonial Governments
English & Foreign RAILWAYS.

Prices According To Quantity On Application.

WEST BROMWICH.

Telephone 216. W.Bromwich. London Office. 5A Lime St. E.C. Telegraphic Address. "SALTER" W.Bromwich.

8615

TELEGRAMS:—
DOUGLAS, KIRKCALDY.
CODES:—
A 1,
A B C, 5th Edition.
ENGINEERING.

'PHONE:—
105,
KIRKCALDY
(2 lines).

WE MANUFACTURE
ALL CLASSES OF MACHINERY
FOR

DOCKYARDS & SHIPYARDS.

MARINE ENGINES & SHIPS' MACHINERY.

Repairs Executed Afloat or Ashore.

DOUGLAS & GRANT, Ltd.,

KIRKCALDY, SCOTLAND. 8431

PENMAN & Co LTD

8257

CALEDONIAN BOILER WORKS, GLASGOW.

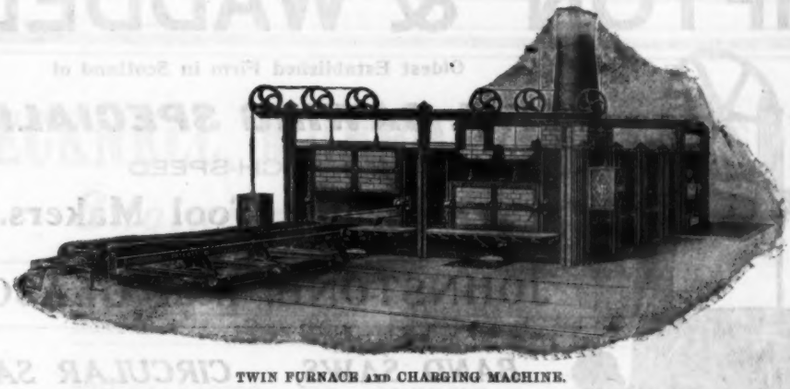
EXPANDED METAL.

For PRICES, SAMPLES, etc. apply to—

The EXPANDED METAL COMPANY, LTD.

6013

Head Office: YORK MANSION, YORK STREET, WESTMINSTER, LONDON, S.W. 1.
Telephones: Victoria 8809 (2 *lines*). *Telegrams: "Distend, Vic., London."*
Works: STRANTON WORKS, WEST HARTLEPOOL.
Telephones: West Hartlepool 94 (2 *lines*). *Telegrams: "Expansion, West Hartlepool."*



TWIN FURNACE AND CHARGING MACHINE.

This Machine enables one man to load in one minute.

HEAT TREATMENT COSTS (FUEL ONLY.)

ANNEALING (Non-ferrous) 1/- per ton of metal.
NORMALISING - - - 1/6 „ „ „
HARDENING - - - 1/6 „ „ „

The above figures are every day practice with users of the "SMALLWOOD" PATENT FURNACES.

Place your requirements before us and we shall be pleased to submit Specifications with guarantees as to Fuel Consumption, Uniformity of Heating, and suitability for the work in hand. 8287

THE INCANDESCENT HEAT Co. Ltd.

Cornwall Road, - SMETHWICK, Birmingham.

Telegrams :—"Repeat," B'ham. Telephone: Smethwick, 276.

HARVEY

Engineering Co.,

LATE LTD.,

M'ONIE, HARVEY & CO., LTD.

Scotland Street Engine Works,
Head Office: 224, West Street,

GLASGOW.

London Office: 27, Mincing Lane, E.C.

ESTABLISHED OVER 50 YEARS.

MAKERS OF ALL KINDS OF

SUGAR MILLS

INCLUDING

PATENT FIVE ROLLER MILLS.

HARVEY'S

Triple-Effet . . . . Evaporator

Now in use in all Sugar Growing Countries.

AND EVERY REQUISITE FOR

Sugar Plantations.

SPECIALTY.

SUGAR REFINERIES

fitted up complete for refining all classes of sugar.

HIGH-CLASS

ENGINES

OF THE HEAVIEST TYPES.

MULTITUBULAR, CORNISH AND LANCASHIRE BOILERS.

TANKS & WROUGHT IRON WORK 8660

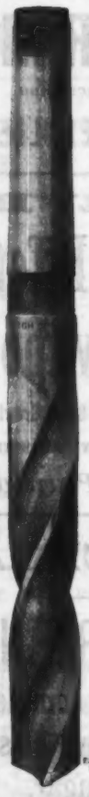
OF EVERY DESCRIPTION.

Telegraphic Address: "Maconie, Glasgow."
Cable Codes used: A B C, A1, Liebers, Western Union, Engineering and New Business.

HIGH SPEED DRILLS

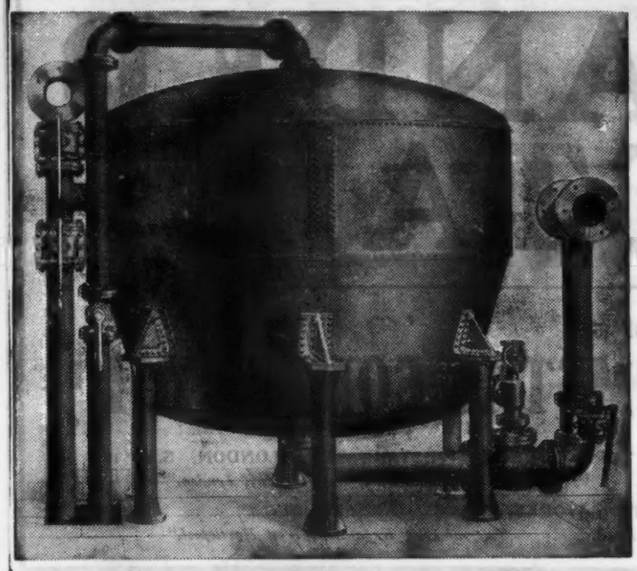
A high-speed twist drill that bears the "CHATWIN" stamp can be depended upon!

It is adapted for use in the hardest and toughest materials—under the most severe drilling conditions..



It is made for hard service by special methods of manufacture and is guaranteed as to shape, clearance and perfect temper.

THOMAS
CHATWIN
LIMITED 7199
VICTORIA WORKS
BIRMINGHAM
C.M.C.



ROYLES
PRESSURE FILTER.

Largely used for filtering River, Canal, and other Waters for Manufacturing purposes.

All matters in suspension removed, and a clear water produced from turbid sources.

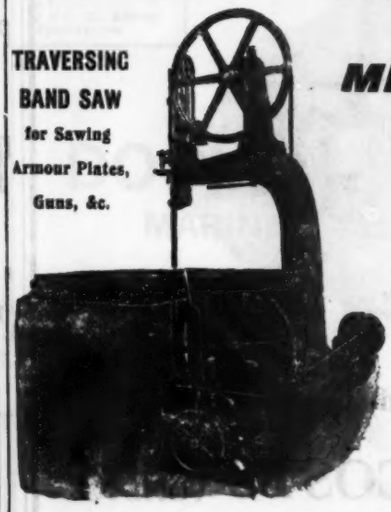
Cleansed in 5 minutes by means of Steam Air Injector and back flush of water.

Waters analysed, and advice on treatment for any particular requirements free of charge. 8035

ASK FOR CATALOGUE.

ROYLES LIMITED,
ENGINEERS AND SPECIALISTS.
IRLAM, nr. MANCHESTER.

CLIFTON & WADDELL,



TRAVERSING BAND SAW for Sawing Armour Plates, Guns, &c.

Oldest Established Firm in Scotland of

METAL SAWING SPECIALISTS,

HIGH-SPEED
Machine Tool Makers.

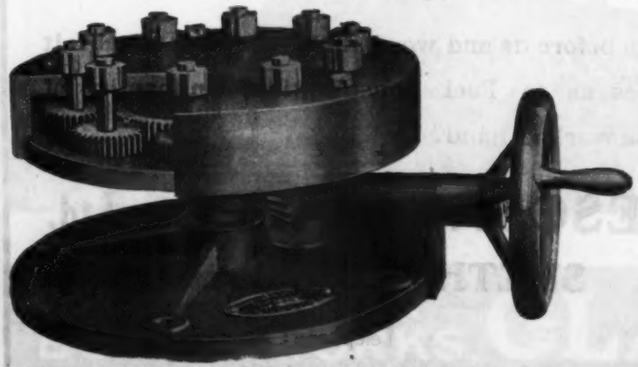
JOHNSTONE, near GLASGOW.

BAND SAWS, CIRCULAR SAWS,
HOT SAWS, DISC SAWS.

BEST AND MOST UP-TO-DATE DESIGNS. 7078

Over 1000 Machines in use.

Mass Production



For Lacquering, Painting, Enamelling, Japanning or Varnishing Small Articles

IN BULK

there is no quicker method than by using the

AIROSTYLE ROTARY - SPINDLE TURNTABLE
(Sterling Patent No. 104464)

in conjunction with a satisfactory 8683

SPRAYING PLANT.

THE AIROSTYLE & LITHOS, Ltd., ENGINEERS, 35, ST. BRIDE STREET, LONDON, E.C. 4.

Telephone: No. 296 Smethwick (4 Lines).
Telegraphic Address: "Carriage," Smethwick, Birmingham.

THE

Grand Prix,
Buenos Ayres Exhibition, 1910.

BIRMINGHAM

RAILWAY CARRIAGE AND WAGON CO., LTD.,

FOR HOME SMETHWICK. AND ABROAD.

MANUFACTURERS OF

RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION, INCLUDING ALL-STEEL CARRIAGES.

PRESSED STEEL UNDERFRAMES, BODIES AND BOGIES. 4931

MAKERS OF RAILWAY WHEELS AND AXLES, IRONWORK, AXLE BOXES, CASTINGS, &c.

Sole Manufacturers of Dean & Churchward's Patent "Eitherside" Brake, and Marillier's Patent "Instanter" Coupling.

"DOBBIE-McINNES"

INDICATORS
STEAM FOR AND DIESEL ENGINES.

Optical Indicators for High-speed Motors.

LOGOMETERS FOR TURBINES (Revolution and Direction Indicators)

TANK & DRAFT DEPTH GAUGES.

STABILITY INDICATORS.

BOURDON PRESSURE and Vacuum Gauges.
GAUGE TESTERS.
DYNAMOMETERS.
SPEEDOMETERS.
Engine Room Clocks.

DOBBIE McINNES LIMITED,
57, BOTHWELL ST., GLASGOW.

"ASHTON"

HIGH-GRADE
LOCOMOTIVE POP VALVES
Chime Whistles and Whistle Valves
PRESSURE GAUGES AND GAUGE TESTING SETS
Wheel Recording
Press Gauges

HOBDELL, WAY & CO., LTD.,
124-7, MINORIES, LONDON, E.
Telegrams: "HOBWAYS." Telephone: AVENUE 5810. O 8507
CONTRACTORS TO H.M. GOVERNMENT.

BRECKNELL, MUNRO & ROGERS, LTD.

Engineers and Contractors.

SPECIALISTS IN OVERHEAD LINES AND FITTINGS FOR ELECTRIC RAILWAYS AND TRAMWAYS IN INDUSTRIAL WORKS.

HIGH OR LOW TENSION LINES ERECTED IN ANY PART OF THE COUNTRY.

MAKERS OF PANTAGRAPH COLLECTORS FOR ALL TYPES OF ELECTRIC LOCOMOTIVES, CURRENT COLLECTORS FOR ALL PURPOSES, INSULATION OF ALL CLASSES, LINE EARS, SPLICING EARS, SUSPENSION FITTINGS, SECTION INSULATORS : : ETC., ETC.

8348

Let us Quote for your Requirements.

CATALOGUES ON REQUEST.

Head Offices: THRISSELL STREET, BRISTOL.

Telegrams: "Brecknell, Bristol." Telephone: 3137 and 3138 Bristol.

WELDED WORK

Tubular Transformer Tanks.
Switch Tanks.
Elevator Buckets.
Steam Jacket Pans.
Hardening Pots.
Water, Petrol and Oil Tanks.
Plating Vats.

General Welded Work.
Copper Pans, Cylinders, &c.
Welded Boilers for Hot Water Supply & Heating Apparatus.

R. JENKINS & Co., Ltd.
(Est. 1856). ROTHERHAM.

UMEC

TO SCIENTIFIC INSTRUMENT MAKERS, SHIPBUILDERS, & ELECTRICAL, RAILWAY, TELEGRAPHIC, TELEPHONE, MOTOR and GENERAL ENGINEERS.

By our Chemical Engraving and Dividing Process we produce 7196

The UMEC INSTRUCTION and DIAGRAM PLATES, SCIENTIFIC INSTRUMENT DIALS and SCALES, NAVAL and MILITARY PROTRACTORS and CALCULATORS on IVORINE, CELLULOID, EBONITE & METALS.

Name Plates also Chemically Engraved on Metals, Ivorine, Etc.

UNITED METAL ENGRAVING CO., LD.

Contractors to the Admiralty and War Office,

40, HIGH BRIDGE, NEWCASTLE-ON-TYNE.

Tel. 1938 Central. Telegrams: Impression, Newcastle-on-Tyne.

OXY-ACETYLENE WELDING Co. LTD.,

21a, ST. VINCENT CRESCENT, GLASGOW.

Telegrams: "BRAZING." Telephone: CENTRAL 4012.

CONTRACTORS TO ADMIRALTY AND WAR OFFICE.

CASTING REPAIRS

up to 5 tons. 7911

MATERIAL.—STEEL, WROUGHT IRON, CAST IRON, ALUMINIUM, BRONZE, Etc.

PROCESSES.—OXY-ACETYLENE, ELECTRIC and CAST IRON, BRAZING.

BOLTS, STUDS, NUTS. 8276

BRIGHT WORK A SPECIALITY.

S. MARSDEN & SON, Ltd.

LONDON ROAD, MANCHESTER.

Telegrams—BOLTS, MANCHESTER. Telephone—2021 CENTRAL (3 lines).

MOTORS-DYNAMOS 8040

Telegrams—DYNAMICISTS, GLASGOW. MAVOR & COULSON, LD., 47, BROAD STREET, MILE END, GLASGOW. Telephone—BRIDGETON 920 (3 lines).

Large stocks of all kinds of **SCRAP METALS**

INGOT METAL To all Specifications. ‖ **CASTINGS** General Founders in Non-Ferrous Metals.

E. J. SMITH & CO., Metal Manufacturers and Merchants,

TELEGRAMS / PHONE } ACOCKS GREEN. 208 & 209. Tyseley Metal Works, BIRMINGHAM

8088

THE

BRITON FERRY STEEL CO., LTD.,

BRITON FERRY, SOUTH WALES.

Manufacturers of High-Class Steel by Siemens-Martin :: Acid and Basic Open-Hearth Processes. ::

STEEL.

For Tinplates, Sheets, Agricultural Implements, Wire, &c.

STEEL BARS.

In Small Rounds, Squares, Flats, and Hexagons. Sections and Light Rails.

STEEL BILLETS.

Dead Soft and Carbon Steel for all purposes. Welding and Case-Hardening Steel.

SPECIALITIES.

Alloy Steel for Aircraft and Motor Parts. Dead Soft Steel for Deep Stamping.

TRADE MARK—"VOLFER." 8574

CONTRACTORS TO THE BRITISH AND FRENCH GOVERNMENTS.

THE STEEL PIPE COMPANY, LIMITED,

Telegraphic Address:—
AQUILENTUS, KIRKCALDY.

KIRKCALDY.

Exhaust Pipes.
Water Mains.
Gas Mains.

Steel Chimneys.
Stamped Steel
and Angle Flanges.

Special Pipes for Electric Stations. 6763

LONDON AGENTS:—JOHN WILSON & CO., 39, Lime Street, E.C.

The Duplex Mill "Fool-Proofed" this Motor Frame job.
A boy Runs it.

THESE induction Motor Frames are rough and finish bored in two and a half hours on the W. & B. Duplex Mill. The ease with which this exacting job can be supervised by a boy is a hint of *one* way to keep the soaring pay-roll within sight and reason.

The Lancashire Dynamo and Motor Company find the Duplex Mill a "fool-proof" producer, as the following figures testify. One head rough bores and the other finishes the motor frames for end-plate fit (both ends) and the main bore, laminated core-plate location. The end-plate fit is 16 inches diameter and ⅛ inch deep; the main bore is 14 inches diameter and the frames are just 9 inches long. The end-plates require to "snap" into position; the main bore diameter is equally particular.

The ability to run double operations on similar pieces or to machine entirely different pieces at the same time, because of the independent table drives, is fully appreciated here. We know that we have set a new standard for quality-quantity boring operations, because the evidence is coming in every day. We'll gladly pass on this data to you, and catalogue "A" is ready.

WEBSTER & BENNETT, LTD., 4800

Head Office and Works, Coventry.

W&B

FOREIGN AGENTS: Société Anonyme Alfred Herbert, Paris (France, Spain, Portugal and Switzerland). Societe Anonyme Belge Alfred Herbert, Brussels, Belgium. Societa Anonima Italiana Alfred Herbert, Milan, Italy. Landre & Glinderman, Amsterdam, Holland. Wilh. Sonesson & Co., Malmo (Sweden), Copenhagen, (Norway and Denmark). Alfred Herbert Ltd., Yokohama, Japan. Alfred Herbert (India), Ltd., Calcutta and Bombay, India. Gilbert Lodge & Co., Melbourne and Sydney, Australia. Blair, Reed & Co., Ltd., Wellington, New Zealand. Alfred Herbert Ltd., New York (U.S.A.) and Toronto (Canada).

C. C.
DUNKERLEY
and CO, Ltd.

Iron & Steel
from
WAREHOUSE STOCK.

STEEL JOISTS,
24" × 7½" to 3" × 1½".
STEEL CHANNELS,
15" × 4" to 2⅝" × 1 3/16".
STEEL ANGLES,
8" × 3½" to ⅝" × ⅝".
STEEL TEES,
6" × 6" to ⅜" × ⅜".
STEEL FLATS,
18" × ½" to ¼" × 3/16".
STEEL ROUNDS,
8½" to ¼" dia.
STEEL SQUARES,
5" to ¼" dia.
STEEL PLATES,
3/16" to ⅜" to 8' long.
In all Standard Sections, cold straightened, lengths to 42'.

A LARGE AND VARIED STOCK OF
CROWN IRON,
BEST, BEST SCRAP and BEST TURNING IRON,
HOOPS, SHEETS, CONVEX, &c., &c.
STEEL BRIDGE RAILS,
BRIGHT STEEL, &c.

IRON and STEEL
HOOPS FOR BALING,
Plain & Painted, a Speciality.

COMPOUND GIRDERS,
STANCHIONS, ROOFWORK
and
CONSTRUCTIONAL STEEL
Riveted up on the Premises from Stock Material.

THE "AJAX" 3613
PATENT CONVEYOR TANK
for handling Metal Scrap, Coal, &c.

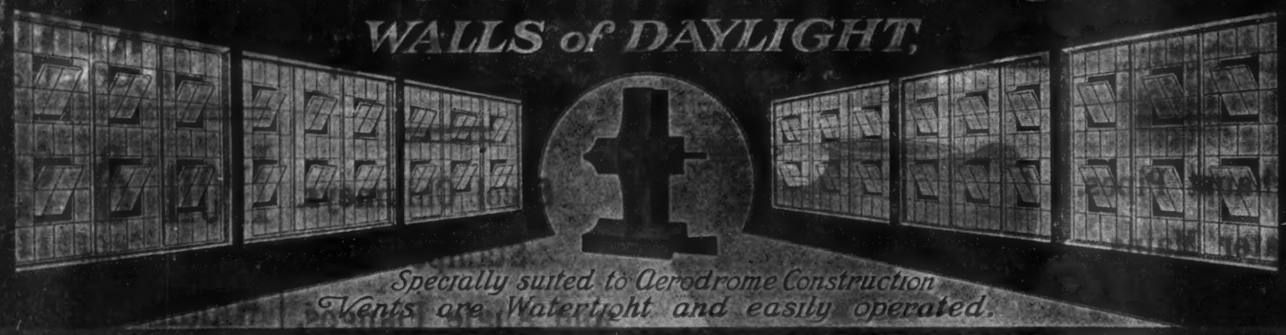
ENQUIRIES SOLICITED.
Section Book on application.

Telegrams: "AJAX, MANCHESTER." Telephone: 6490-6 (six lines).

STORE STREET
Iron and Steel Warehouses,
MANCHESTER.

HOPE'S · LOK'D-BAR · SASH

WALLS of DAYLIGHT.



Specially suited to Aerodrome Construction
Vents are Watertight and easily operated.

55, LIONEL ST. BIRMINGHAM. 59, BERNERS ST. LONDON, W.

McKENZIE & HOLLAND, Ltd.
Railway signalling of every description.
POWER SIGNALLING
carried out in conjunction with
The McKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO., LTD.,
Head Offices: 58, Victoria Street, London, S.W.
Telegrams: "Macksig, London." Works: Worcester, England. Telephone, 4760 Victoria. (Two Lines.)
8267

CHEKKO
Brake & Clutch Linings

HAVE 30 YEARS' MANUFACTURING EXPERIENCE BEHIND THEM.
Are used by over 400 Collieries, many hundreds of Engineers, Crane Makers, &c., and a host of the leading Chassis Builders of motor wagons and cars, London and other Omnibus Companies, &c., at Home and Abroad. :: :: :: ::
Send postcard for sample, prices and terms, to the sole manufacturers,
CRESSWELLS' LIMITED,
WELLINGTON MILLS, BRADFORD, YORKS.
11, Bothwell Street, Glasgow; Baltic Buildings, Gloucester Place, Swansea; 44, 45, Exchange Buildings, New Street, Birmingham.
Telegrams: "Asbestos," Bradford. Telephone: 950 Bradford
Contractors to the Admiralty, India Office, War Office, Crown Agents for Colonies, numerous British Railways, &c. 6362

Ship, Tank, Bridge,
On Admiralty and
SIEMENS OPEN HEARTH STEEL
Firebox and Special Plates.
Board of Trade Lists.
BOILER PLATES
Soft Welding and Flanging Plates for Furnace and other purposes.
STEWARTS AND LLOYDS, LTD.
41 OSWALD STREET, GLASGOW.
7710

DAVID COLVILLE & SONS, Ltd.

GLENGARNOCK IRON & STEEL WORKS, GLENGARNOCK.

CLYDE BRIDGE STEEL WORKS, CAMBUSLANG.

DALZELL STEEL & IRON WORKS, MOTHERWELL.

Head Office: MOTHERWELL.

BOILER BRAND.

SHIP & BRIDGE BRAND.

PLATES, RAILS, JOISTS & BARS

IN SOFT, MILD, MEDIUM, HIGH TENSILE, H.H. TENSILE, NICKEL AND ALLOY STEEL.

8140

NICKEL CHROME BRAND.

NICKEL STEEL BRAND.

COMPOUND UNDERTYPE STEAM ENGINES

CONDENSING AND NON-CONDENSING.

EFFICIENT & ECONOMICAL IN FUEL

From 24 to 190 Effective HP.

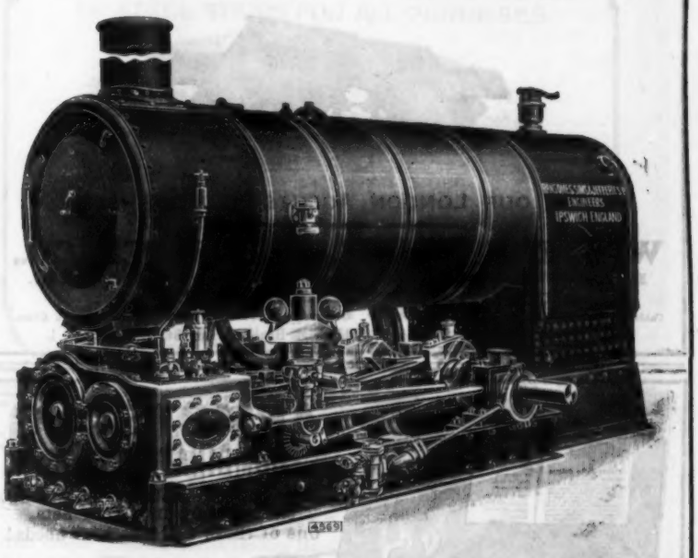
8602

RANSOMES, SIMS & JEFFERIES, LD.,

ORWELL WORKS, IPSWICH,

AND

46, QUEEN VICTORIA STREET, LONDON, E.C. 4.



STEEL BARS, FORGINGS & CRANKS

MILD & HIGH TENSILE STEEL. NICKEL & NICKEL-CHROME STEEL. CASEHARDENING & GEAR STEEL.

HIGH SPEED & CAST TOOL STEELS.

CASTINGS MALLEABLE IRON. CAST STEEL.

STRINGER & CO. SHEFFIELD LTD.

WINCOBANK STEEL WORKS, SHEFFIELD.

'Phone: 22 ATTERCLIFFE.
'Grams: "Stringer, Wincobank."

8041

McKIE & BAXTER

ENGINEERS, SHIPBUILDERS, BOILERMAKERS, COPLAND WORKS, GLASGOW.

Telegrams: "CALIDAD, GLASGOW."

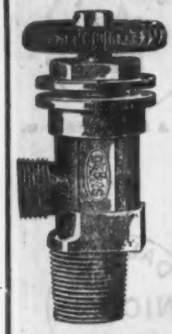
Codes: A 1 A B C, Engineers and Private Code

8396

SPECIALITY.—MACHINERY FOR VESSELS CONSTRUCTED ABROAD.

Correspondence Invited.

VALVES for CARBONIC ACID BOTTLES



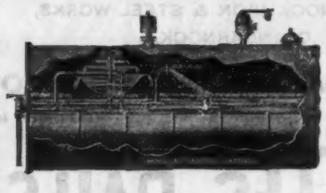
TWENTY-FIVE YEARS' EXPERIENCE, backed up by modern methods enables me to offer VALVES for:—

Oxygen, Hydrogen, and Coal Gas Bottles,
Carbonic Acid Bottles,
Nitrous Oxide Bottles,
Sulphurous Acid Bottles,
Ammonia Bottles,
Chlorine Bottles,
Refrigerating Plant, 8127

that are absolutely reliable. Valves are all made from Drop Steel or Brass Forgings (not Castings, as very often employed), and are guaranteed to have been efficiently tested under gas pressure before despatch from my works. I invite enquiries and correspondence, which shall have my best attention at all times.

DAVID SCOTT, CATHKIN ENGINEERING WORKS, POLMADIE, GLASGOW.

Tranters Improved Feed-water Detartarizer



Boiler Disincrustants.
Boiler and Pipe Coverings
(Magnesia, Asbestos, Fossil Meal, &c.)
Lubricating Oils and Greases
Soluble Oil & Cutting Compounds.

W. J. TRANTER, LIMITED,
Tibbington Works, Princess End, TIPTON, Staffordshire. 8268
Telephone—76 Tipton. ESTABLISHED 1890. Telegrams—"Titan, Tipton."

RAILWAY TIPPING WAGONS—
AIR OPERATED.

ASK OUR LONDON AGENTS ABOUT THEM.

WESTERN WHEELED SCRAPER CO.,
Earth and Stone Moving Machinery, 8263 Founded 1877.
AURORA, ILLINOIS, U.S.A.
Cable Address—WESTERN, AURORA, ILLINOIS. Codes used—A1, A B C (4th and 5th Editions), Western Union.
British Agents: George F. West & Co., Iddesleigh House, Caxton St., London, S.W. 1.

E. SHOWELL & SONS,
LIMITED
STIRCHLEY, - - BIRMINGHAM.

STEEL FORGINGS
FOR THE MOTOR, CYCLE, AND OTHER TRADES.
7859

ARMSTRONG COMBINATION KITS.
Made up of Tools of Armstrong Manufacture into Four Sets.
One of these will suit your needs!

Our CATALOGUE No. 14, lists each outfit, giving sizes of tools, weight of complete kits, &c. The Catalogue is yours if you ask for it.

MADE UP AS FOLLOWS—
One Genuine Armstrong STOCK and DIES ¼ to 1 in. R. or L.;
One Model B PIPE CUTTER;
One Junior Hinged PIPE VISE;
One Stillson PIPE WRENCH.
All put up in a Hardwood Box.
8345

THE ARMSTRONG MFG. CO., 338, Knowlton Street, BRIDGEPORT, CONN., U.S.A. | NEW YORK Office: 248, Canal Street.

SIMPLEX CONDENSER TUBE BRUSHES

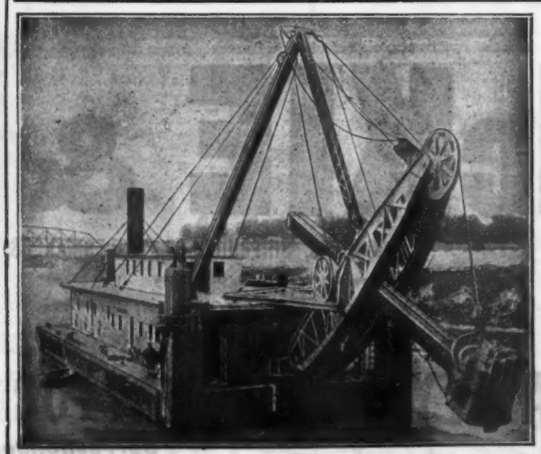
USED REGULARLY, GIVE
CLEAN TUBES AND CONSEQUENTLY
HIGHER VACUUM.
FOR HARDER SCALE USE SIMPLEX CONDENSER TUBE SCRAPERS.
COMPLETE LIST OF "SIMPLEX" SPECIALTIES ON REQUEST.

BROMELL PATENTS CO., LTD.,
(WM. CROCKATT & SONS, Managers.)
64, DARNLEY STREET, GLASGOW. 7987

PHONE: CENTRAL 3220
TELEGRAMS: "WINDTIGHT."

CORROSION PITTING AND SCALE
CAN BE PREVENTED IN CONDENSERS, BOILERS, ETC.,
BY INSTALLING
THE "HARRIS-ANDERSON" ELECTRICALLY AUGMENTED PROTECTIVE SYSTEM. 8084

WRITE FOR PARTICULARS TO
THE HARRIS PATENT FEED WATER FILTER (1910) LTD.,
24 GRAINGER STREET WEST.
NEWCASTLE-ON-TYNE.



BUCYRUS CO.,
South Milwaukee.

DIPPER DREDGERS.

Lowest first cost, easiest type to handle; best for hard material; by far the most economical for subaqueous rock work.

Also
SUCTION DREDGERS
GOLD DREDGERS.
STEAM & ELECTRIC SHOVELS.
DRAG LINE EXCAVATORS.
PILE DRIVERS.
7910

Sole British Agents—
GEORGE F. WEST & CO., Iddesleigh House, Caxton St., London, S.W.1.

FIT YOUR LARGE DUPLEX PUMPS WITH TWELLS' PATENT GEAR AND SAVE COAL

F.

8549

Twells' Patent Valve Gear (Duplex Pump) Co. Tudor Chamber, 25, Millstone Lane Leicester.

BUCK & HICKMAN METHODS

We test an article in our Demonstrating Showrooms before putting it on the market. This wheel has made good on fine Gauge work; and with coarse grit on trimming castings.

Canadian A. E. W. Wheels

Corundum 100,000 in Stock

8521

BUCK & HICKMAN, LTD., 2-4, Whitechapel Rd., LONDON, E. 1.

The BRADLEY 3-ROLL MILL

The 20th Century Marvel for Grinding

PHOSPHATE ROCKS, LIMESTONE, COAL, PORTLAND CEMENT, ORES of all kinds.

REQUIRES NO AUXILIARY APPARATUS FOR FINISHING PRODUCTS

SATISFACTION GUARANTEED.

Full particulars on application to— 8256

BRADLEY PULVERIZER CO., 37, WALBROOK, LONDON, E.C. 4.

COLD ROLLING MILLS

OF STEEL STRIPS FOR ALL PURPOSES

ED. MATHEY SON. LTD.

NEUVEVILLE

(SWITZERLAND)

SEALOMENT (*Regd.*)

A Liquid Chemical That Makes Concrete Permanently Waterproof

BEING permanently beneficial to Concrete in every way, SEALOMENT is indispensable for concrete houses. It accomplishes such remarkable results, at so little extra cost, that no one interested in concrete construction should be without it.

SEALOMENT not only waterproofs concrete, but it prevents concrete from freezing at ordinary low temperatures, and increases its tensile strength. Walls rendered with cement and sand, into which SEALOMENT is mixed, can be decorated immediately they have thoroughly set, thus effecting a great saving in time and money.

Being a liquid, SEALOMENT ensures absolute uniformity in mixing, without any trouble—a great advantage. There is no finer material for Flat Roofs, Damp Walls, Cellars, Reservoirs, etc.

Sole Proprietors: ROWSE & COMPANY, 8057 1, Dawson Street, Whitechapel, LIVERPOOL.

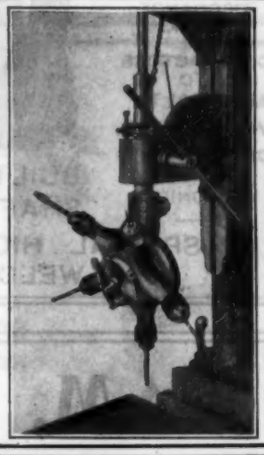
THE

FORTIN TURRET HEAD

(Patent Oct. 29, 1918).

Will Drill, Ream, Counterbore and Spot-Face Without Moving Your Work.

This simple 5-Spindle Turret Drilling Head saves much time where tools of various sizes are used on the same piece. Takes but little more room than a chuck and is indexed very quickly by simply pressing lever at the front. Simple, compact and strong. Made in 5 sizes up to 2-inch drill.



CARRIED IN STOCK BY—

BUCK & HICKMAN, LONDON.

Write to-day for full information and prices.

SPAFFORD TOOL WORKS, 8486

Hartford, Conn., U.S.A.

Cable Address: "SPAFTOOL, Hartford Conn."

PIPE LINES

8117

WATER, STEAM, OIL, AIR, GAS, HYDRAULIC.

CONTRACTS COMPLETED THROUGHOUT UNITED KINGDOM AND ABROAD.

J. W. HOUSTON & CO., PATRICK CROSS, GLASGOW.

WESTINGHOUSE

AIR BRAKES

for

HEAVY and LIGHT TRACTION by STEAM or ELECTRICITY

Manufactured in London by—

THE WESTINGHOUSE BRAKE CO., LTD., 82, YORK ROAD, KING'S CROSS, LONDON, N. 1.

ON ADMIRALTY LIST.

Telegrams:
BESSEMER, SHEFFIELD.

Telegrams.
BESSEMER, BOLTON.

HENRY BESSEMER & CO. LD.

SHEFFIELD,

STEEL MANUFACTURERS.

AND AT BOLTON (LANCS.)

SPECIALITIES.

FORGE INGOTS UP TO 25 TONS.

FORGED CHROME STEEL SHOES AND DIES.
FOR GOLD MINING PURPOSES.
LARGEST OUTPUT OF ANY ENGLISH FIRM.

ROLLERS AND PATHS FOR QUARTZ CRUSHING.

NICKEL & CASE HARDENING STEELS.

HIGH TENSILE STEEL FOR WIRE DRAWING & ORDNANCE WORK.

CONTRACTORS TO ADMIRALTY, WAR OFFICE, CROWN AGENTS FOR THE COLONIES.

BUILT-UP AND SOLID CRANK AXLES, WITH GUARANTEED MILEAGE, AND CRANK SHAFTS, TYRES, AND AXLES, OF ALL TYPES, for Railways, Tramways, &c.

SPECIAL HIGH-TENSILE TYRES, "ARGENTINE" BRAND, for Locomotives, &c.

WELDLESS CRANK HOOPS, BOILER RINGS AND ANGLE RINGS.

SPECIALITIES.

SHAFTING OF ALL DESCRIPTIONS FOR MARINE AND LAND ENGINES.

ROLLED BARS, FLATS, ANGLES, COLLIERY RAILS, FISHPLATES, SPRING STEEL AND SPECIAL SECTIONS.

REELED BARS.

BILLETS & BLOOMS FROM 2"—12" SQ.

CONTRACTORS TO COLONIAL, INDIAN, & FOREIGN GOVERNMENTS

BRITISH & FOREIGN RAILWAYS, &c.

1949

HAM, BAKER & CO., Limited,

CARRY LARGE STOCKS

READY FOR IMMEDIATE DELIVERY

OF

SLUICE, REFLUX and AIR VALVES,
HYDRANTS, SURFACE BOXES, PENSTOCKS, &c.

Address—

HAM, BAKER & CO., Limited, *Engineers, Iron & Brass Founders,*

Telegrams—
PENSTOCK, LANGLEY, WORCS.

Langley Green, BIRMINGHAM.

Telephone—
87 OLDBURY.

1949

STEEL & IRON
FORGINGS
SOMERS
HALESOWEN

DROP FORGINGS

FOR THE ENGINEERING TRADES MADE IN

STEELS to any analysis, special attention being paid to the heating and working of Carbon, Nickel, Nickel Chrome, Chromium, Chrome Vanadium, and other Alloy Steels.

HEAT TREATMENT carried out under the direct supervision of our laboratory to meet all Engineering Standards Committee, Air Board, Admiralty, War Office and other Specifications and Tests.

SEND YOUR ENQUIRIES TO—

SMETHWICK STAMPING CO.

(Proprietors : Valor Co., Ltd.) Bridge Street, Smethwick.

NILES-BEMENT-POND CO.

MACHINE TOOLS

For Railroad Shops and General Manufacturing

DUPLEX CONTROL BORER, DRILLER AND MILLER.
May be operated from either side. Every lever and hand wheel shown on the front is duplicated on the other side of machine

Machine Tools for Locomotive, Car and Railroad Repair Shops

LATHES, Driving Wheel: 51 in. to 90 in. swing. Car Wheel. Axle.
WHEEL PRESSES: Capacities, 200 to 600 tons, and to take wheels from 42 in. to 90 in.
CAR WHEEL BORING MACHINES, to take wheels up to 42 in.
AXLE CENTERING AND CUTTING-OFF MACHINES.
WHEEL QUARTERING MACHINES.
STEAM HAMMERS: single and double frame.
STEAM DROP HAMMERS, &c.
CRANES, TRAVELLING CRANES, HOISTS, &c.

Machine Tools for General Manufacturing

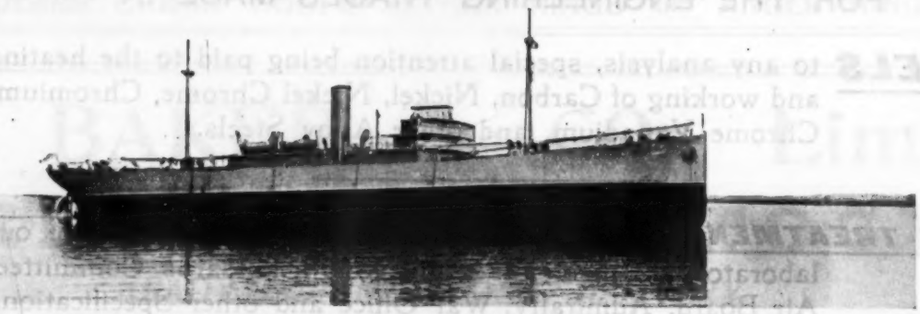
LATHES: From 9 in. swing up to meet any requirement
PLANERS: From 30 in. up to meet any requirements.
BORING MILLS: 36 in. swing up to meet any requirements.
SLOTTERS: 6 in. to 99 in. stroke.
DRILLING MACHINES: 24 in. to 60 in. RADIAL: 4 ft., 5 ft., 6 ft., semi and full universal; also heavy duty type up to 10 ft. MULTIPLE SPINDLE: 2, 4, and 6 spindles, in variety of types.
MILLING MACHINES: Built in variety of types and sizes to suit customers requirements.
SHAPERS: Travelling Head. Single or Double, 22 in. and 36 in. stroke.
HORIZONTAL BORING AND DRILLING MACHINES.
HORIZONTAL BORING, DRILLING AND MILLING MACHINES.
CYLINDER BORING MACHINES.

General Offices: 111, Broadway, New York. O 5433 London Office: 25, Victoria Street, S.W.
For Canada: The John Bertram & Sons Co., Ltd., Dundas, Montreal, Toronto, Winnipeg, Vancouver.

SUN SHIP

SUN SHIPBUILDING CO.

SHELTER DECK
CARGO VESSELS
LENGTH 435 FT.
BEAM 57 FT. 6 IN.
DEPTH 38 FT.
D.W. 10,375 TONS.



TRIPLE EXPANSION ENGINES
27.45½.76
51
THREE SCOTCH BOILERS

CAPACITY OF SHIPYARD—EIGHT BUILDING WAYS, TWO LARGE WET DOCKS.
BUILDERS OF HIGH CLASS SINGLE AND TWIN SCREW PASSENGER AND CARGO VESSELS, BULK OIL TANKERS, UP TO 600 FEET IN LENGTH.
ENGINE BUILDERS. BOILER MAKERS.
IRON FOUNDERS. SHEET METAL WORKERS. 6832
EXTENSIVE FACILITIES FOR SHIP, ENGINE AND BOILER REPAIRS.

Main Office & Shipyard - - Chester, Penna., U.S.A.

8447

The Oldest and Largest Manufacturers of Oilfield Equipment.

DASHWOOD HOUSE, LONDON, E.C. 2.

ROBEY ENGINES

The experience of over half a century in the manufacture of many thousands of drop valve engines is embodied in the Robey Uniflow Engine.

In Efficiency and Economy it stands alone.

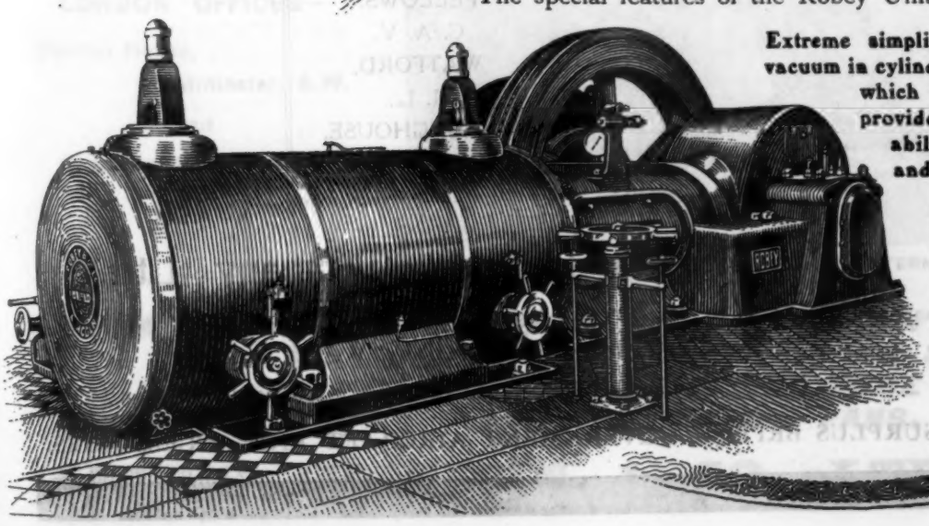
The special features of the Robey Uniflow Engine are:—

Extreme simplicity and low upkeep costs—High vacuum in cylinder—Accessibility of working parts which are all totally enclosed and provided with forced lubrication—Suitability for high steam pressure and all degrees of super-heat.

It is as efficient and economical as a high class triple expansion engine.

8448

Catalogue No. 246 on application.



ROBEY & Co LTD.
GLOBE WORKS LINCOLN

Royce Ltd.

Trafford Park, MANCHESTER.

ELECTRICAL CRANES and WINCHES.

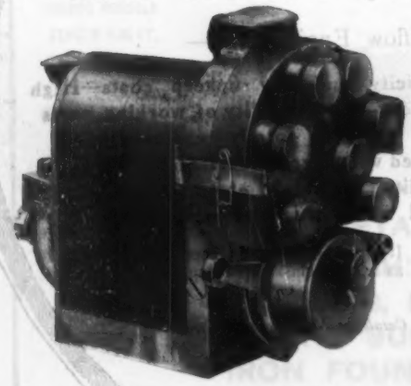
8080

NEW MAGNETOS

IN STOCK . . . . .

50,000

B. T. H.,
BOSCH,
SIEMENS,
FELLOWS,
C. A. V.
WATFORD,
M. L.,
WESTINGHOUSE,
etc.



Aircraft Disposal Company Ltd.

Managing Agents: HANDLEY PAGE Ltd.,
Regent House KINGSWAY London

"Airdisco, Westcent." Regent 5621 (Three Lines)

8043

PURCHASERS OF ALL THE SURPLUS BRITISH GOVERNMENT AIRCRAFT AND ACCESSORIES.

MANLOVE'S
EVAPORATORS

Makers of :—

VACUUM PANS,
DISTILLING VESSELS,
EVAPORATORS,
MULTIPLE EFFECTS,
SAVE-ALLS,
CONDENSERS,
STAGING,
Etc., Etc.

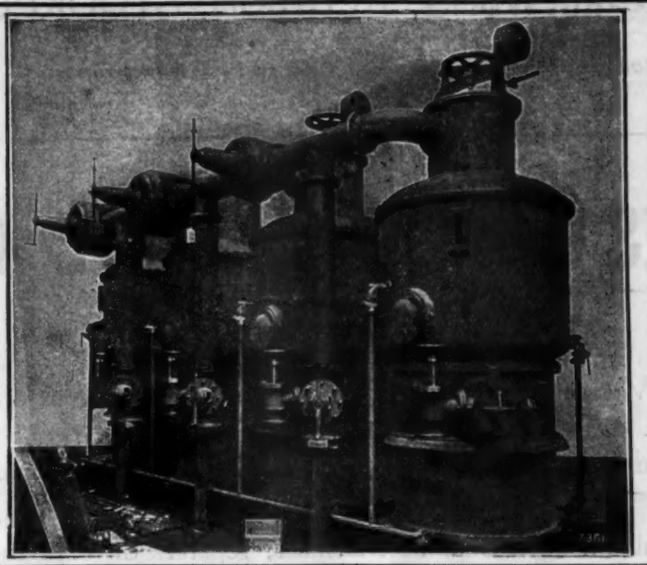


ILLUSTRATION SHOWS QUADRUPLE EFFECT EVAPORATING PLANT for BRINE.

SEND PARTICULARS OF YOUR EVAPORATING PROBLEMS AND WE SHALL BE PLEASED TO GIVE ADVICE.

WRITE FOR LIST S. 179.

MANLOVE, ALLIOTT & CO., LTD.,
BLOOMSGROVE WORKS, **NOTTINGHAM.**
London Office :—41 & 42, PARLIAMENT STREET, WESTMINSTER, S.W. 1.

8300

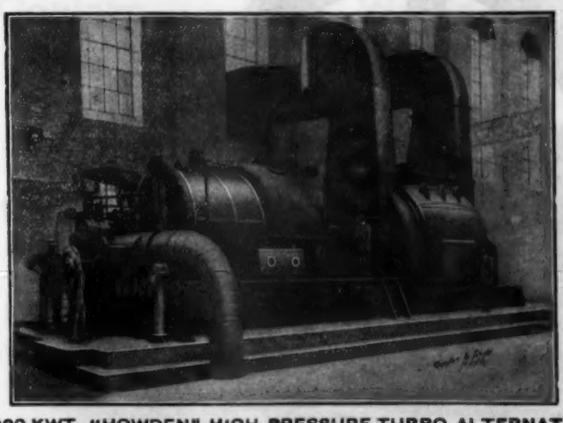
JAMES HOWDEN & CO., LD., GLASGOW.

MANUFACTURERS OF

"IMPULSE" STEAM TURBINES, SPECIALLY RECOMMENDED FOR LARGE UNITS.

HIGH-SPEED STEAM ENGINES.

LONDON OFFICES—
Caxton House, Westminster, S.W.
and
9, Billiter Square, E.C.



15,000 KWT. "HOWDEN" HIGH PRESSURE TURBO ALTERNATOR
Installed at Manchester Corporation Electricity Works.

MANCHESTER—
86, Cross Street.

NEWCASTLE—
90, Pilgrim Street.

BELFAST—
137, Royal Avenue

PATENTEES AND MANUFACTURERS OF HOWDEN'S FORCED DRAUGHT; WALLSEND-HOWDEN OIL BURNING SYSTEM. PATENT COMBINATION WATER-TUBE BOILERS; AND VENTILATING FANS.

1045

JAMES HOWDEN & CO., LTD., GLASGOW.

CRAVEN BROTHERS (MANCHESTER) LIMITED,

TELEGRAMS:— CRAVEN, REDDISH.

Vauxhall Works, REDDISH, STOCKPORT

TELEPHONE:— No. 421 HEATON MOOR.

Contractors to the War Office, Admiralty, Colonial and Indian Governments. — *Established 1853.*

MACHINES FOR IMMEDIATE DELIVERY.

Six High-speed 4ft. Vertical Drilling Machines, single pulley all gear drive.
Spindles 3in. diameter; 15in. traverse.
Capable of drilling 1½in. diameter hole at 5in. per min. in mild steel.

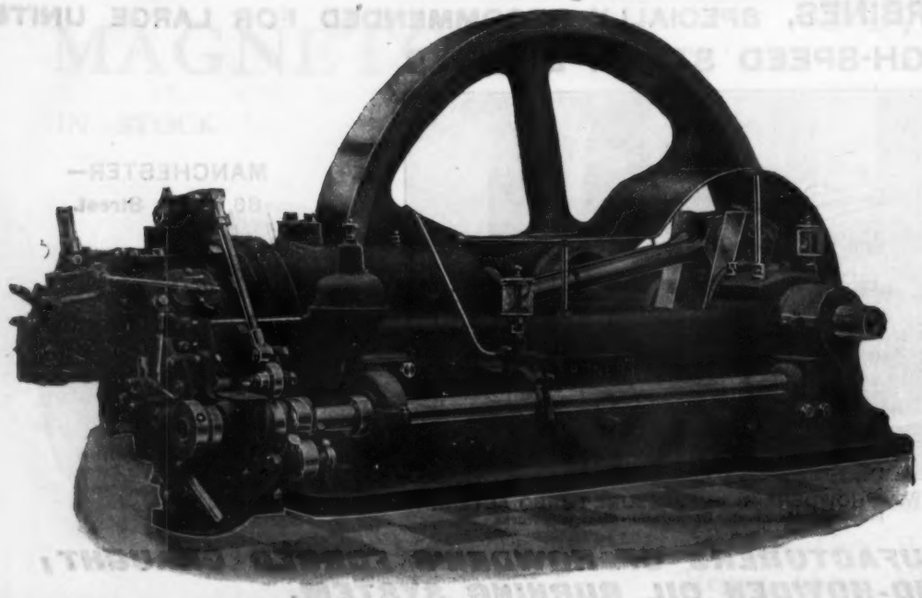
Five 16in. stroke Double-headed Shaping Machines, separate drive to each head.
Two tables; bed 8ft. 3in. long; 5ft. centres of rams max.

One 8½in. Centre Electrically-driven Self-acting Sliding, Surfacing and Screw-cutting Gap Lathe, to admit 4ft. between the centres.

8168

GARDNER OIL AND GAS ENGINES

From ¼ to 200 B.HP.



7515

GARDNER HIGH COMPRESSION ENGINE FOR CRUDE AND RESIDUAL OILS.

NEWCASTLE SHOWROOMS—NORRIS, HENTY & GARDNER'S, Ltd., Milburn House, (Floor A.), Newcastle-on-Tyne.

GARDNER SUCTION GAS PRODUCERS,
From 15 to 150 B.HP.
SPIRIT ENGINES,
ALCOHOL ENGINES,
HIGH-SPEED VERTICAL ENGINES
For LAUNCHES, HEAVY VEHICLES, &c.
OIL, SPIRIT or ALCOHOL.

L. Gardner & Sons, Ltd.

Barton Hall Engine Works,
PATRICROFT, MANCHESTER.
Telegrams—"THEOREM, PATRICROFT."
Telephone—No. 401 ECCLES (4 lines).

SHOWROOMS
LONDON — NORRIS, HENTY AND GARDNER'S Ltd., Gardner House
115, Queen Victoria St., E.C.
Telephone—CITY 9493 & 9494.
Telegraphic Address:—"NORNODESTE, CANNON, LONDON" (Charged as two words only).
GLASGOW - 124, St. Vincent St.
LIVERPOOL: 701, Tower Bldg., Water St.

"HOFFMANN"

THE BEARINGS OF ESTABLISHED REPUTATION

BALL BEARINGS

We *SPECIALISE* in

Air Filters. Air Coolers.
Oil Coolers. Water Coolers.
Dynamometers.
Refuse Destructors.
Refrigeration Machinery.
Electrically-Operated Freight Trucks.

SOUND EXPERIENCE OF THESE SPECIALITIES ENABLES US TO OFFER YOU THE BEST MODERN EQUIPMENT OBTAINABLE.

WRITE FOR PARTICULARS:—

T399

HEENAN & FROUDE LTD., WORCESTER, ENGLAND.

SPANNERS.

Single and Double-Ended. All sizes up to 2" supplied from stock.

***SPECIAL SPANNERS* made for following trades:—**

ENGINEERING
SHIPBUILDING
CONSTRUCTIONAL
BRIDGE BUILDINGS
MOTOR CARS AND LORRIES
AGRICULTURAL IMPLEMENTS
RAILWAY PERMANENT WAYS
MACHINE TOOLS
LOCOMOTIVES
WATER DEPARTMENTS

ARMSTRONG, STEVENS & SON, LTD., WHITTALL ST., BIRMINGHAM.

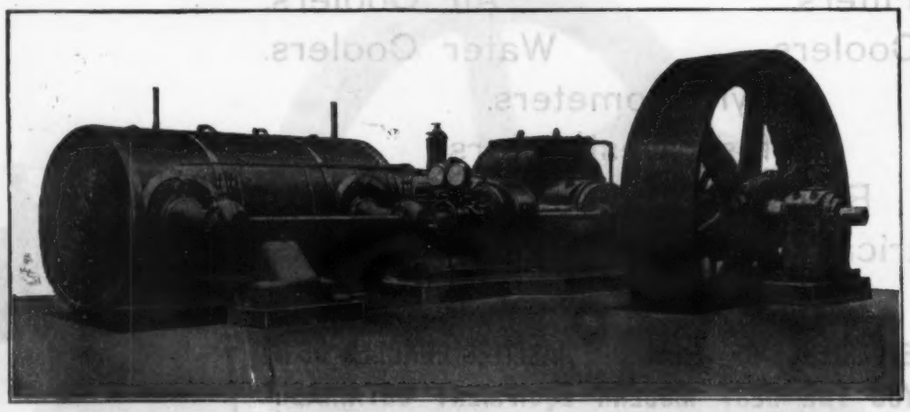
WORKS:—WILLENHALL.

8075

PRICES QUOTED ON APPLICATION.

THE LILLESHALL CO., LTD. OAKENGATES, SHROPSHIRE.

Telegrams—"LILLESHALL, OAKENGATES." Telephone—28, OAKENGATES.



ENGINES

for Winding, Hauling, Blowing, Pumping, Rolling.

UNIFLOW ENGINES,
GAS ENGINES,
400 to 4000 B.HP.

COKE OVEN PLANT.

COMPLETE EQUIPMENTS :—

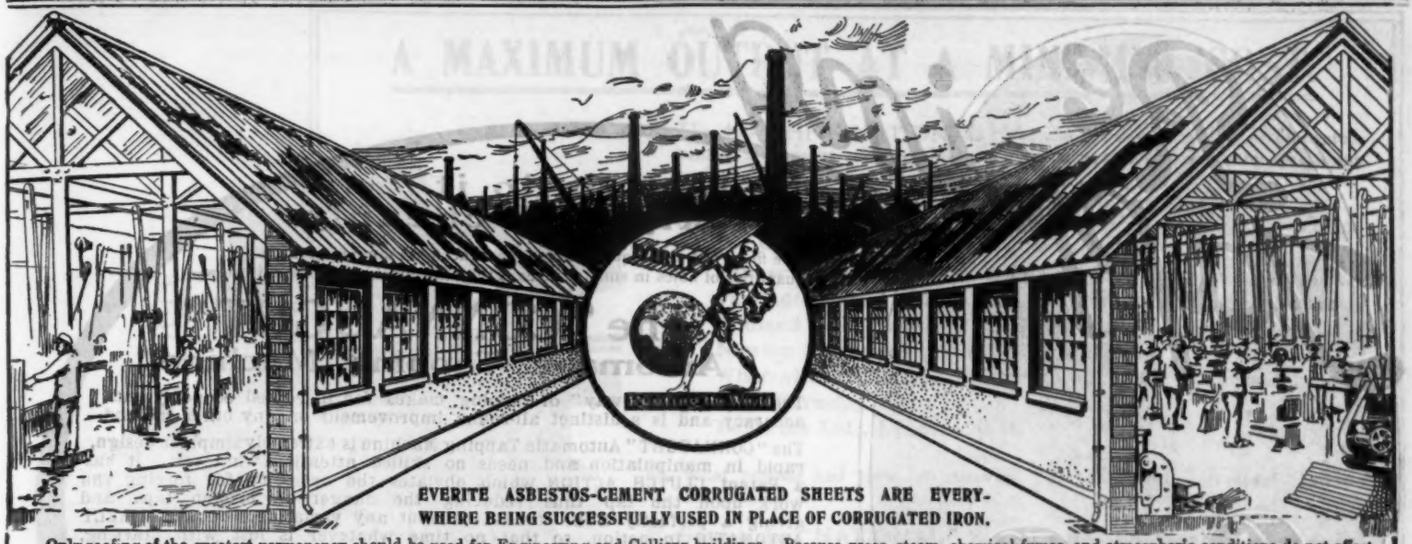
BLAST FURNACES. STEEL WORKS. ROLLING MILLS.

8314

COLLIERY PLANT AND CONSTRUCTIONAL WORK

OF EVERY DESCRIPTION.

STEEL PITHEAD GEARS, SKIPS, and TIPPING PATHS. PIT CAGES.



EVERITE ASBESTOS-CEMENT CORRUGATED SHEETS ARE EVERYWHERE BEING SUCCESSFULLY USED IN PLACE OF CORRUGATED IRON.

Only roofing of the greatest permanency should be used for Engineering and Colliery buildings. Because gases, steam, chemical fumes, and atmospheric conditions do not affect it, EVERITE is the most natural material with which to roof Acid Houses, Boiler Houses, Blacksmiths' Shops, Coal Bunkers, Coaling Towers, Dock Sheds, Engine Houses, Elevators, Electric Shops, Forges, Foundries, Generating Stations, Laboratories, Loco Houses, Machine Shops, Offices, Pumping Stations, Power Houses, Storages, Warehouses, &c.

Our Laboratories and Engineering Works for experiment and research ensure a uniformly high grade product of unexcelled merit.

Obtain a Sample of
EVERITE
and convince yourselves that it is not merely waved, but is truly and scientifically corrugated to a great depth. The whole strength of the sheet lies in its depth of corrugation, and in this respect "EVERITE" is pre-eminent.
Illustrated catalogue, quotations, samples and full particulars on application.

EVERITE

7927

CORRUGATED ASBESTOS CEMENT SHEETING.

SOLE MANUFACTURERS:—
British Everite & Asbestilite Works, Ltd.
29, PETER STREET, MANCHESTER, ENGLAND.
Telegrams: Everite Manchester. All Codes. Telephones: City 7790 Manchester.

Asbestilite
(Asbestos-Cement)

tiling is superior to any natural roofing slate ever quarried. It can be had in permanent Indian Red, Staffordshire Blue, Rustic Bronze or Slate Grey. The permanent colouring impregnates the whole substance right through, hence, no painting is ever required.

Like "EVERITE" it is proof against all destructive agencies.

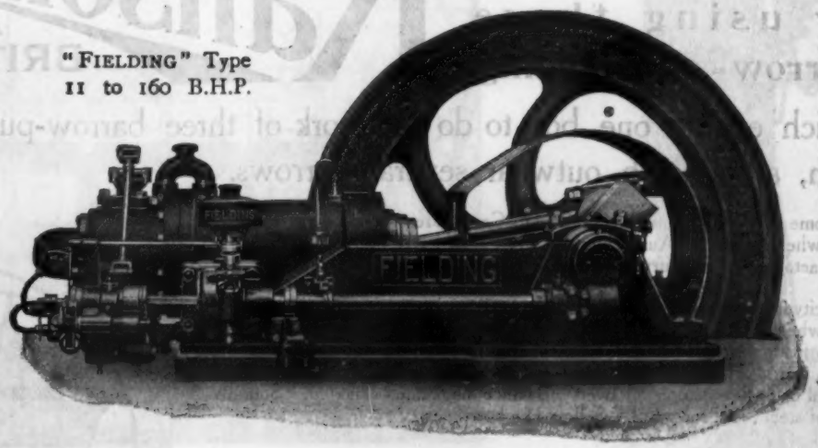
FIELDING (Patent) CRUDE OIL ENGINES

We are also makers of:
Suction Gas Engines,
Gas Plants,
Hydraulic Machinery.

FOREIGN and COLONIAL AGENTS WANTED.

Don't waste money on inferior engines, get the make that is reliable, accurate, and above all dependable, and guaranteed. Fielding Crude Oil Engines will give you every satisfaction. Fitted with our patent Vaporiser and Fuel Injector, and of the four-cycle type, no water injection, they use the same oil as Diesel Engines. Every engine has a thorough working test before leaving our factory. Let us tell you more about them.

"FIELDING" Type
11 to 160 B.H.P.



Write for our Catalogue.

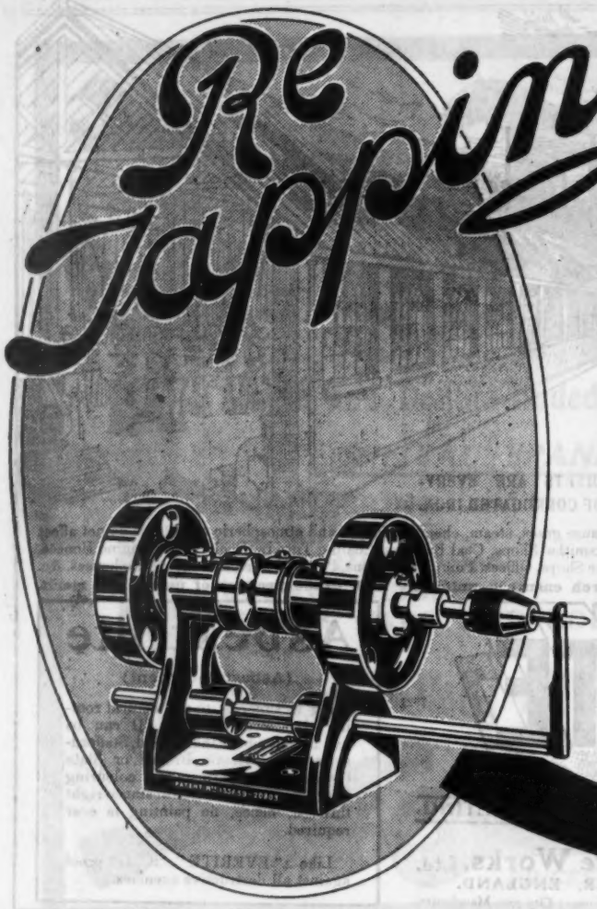
FIELDING & PLATT, LTD.
GLOUCESTER, ENGLAND.

3819

Re Tapping

—how to do it quickly and cheaply.

The finest aid to the quick, efficient and accurate tapping of large quantities of holes in small articles is the little machine illustrated below—



The "CONNAUGHT" Automatic Tapping Machine

The "CONNAUGHT way" of tapping makes for increased economy and accuracy and is a distinct all-round improvement on any other method.

The "CONNAUGHT" Automatic Tapping Machine is extremely simple in design, rapid in manipulation and needs no skilled attention whatever. It has a Patent CLUTCH ACTION which obviates the necessity for forcing the work upon the tap thus reducing the danger of broken taps and giving a perfectly EVEN thread without any variation. It is ENTIRELY AUTOMATIC in action, so that no time whatever is lost with starting, reversing and stopping levers. It is fitted with ⅜ inch PATENT CHUCK and will tap Through or Blind Holes up to ¼ inch diameter.

Price (Subject to market fluctuations.) **£7-14-0** (Carriage paid to any station in U.K.)

The "CONNAUGHT" will quickly cut down tapping costs, and its many sterling features merit the immediate investigation of every manufacturer interested in the tapped hole. Send along your order NOW or write for fuller information direct to

Sole Concessionaire: 8438

H. L. Nathan, 16, Regent Place, B'ham.

Actual size 15 inches long by 5 inches wide by 8½ inches high.
We are shortly producing in larger sizes for Tapping up to ½ inch holes.

8433

H.1.8.

Scrap your barrows!

And save Time, Labour and Money by using these barrow-superseding

Ransome ALL BRITISH

"RAPID-TRANSIT" HAND

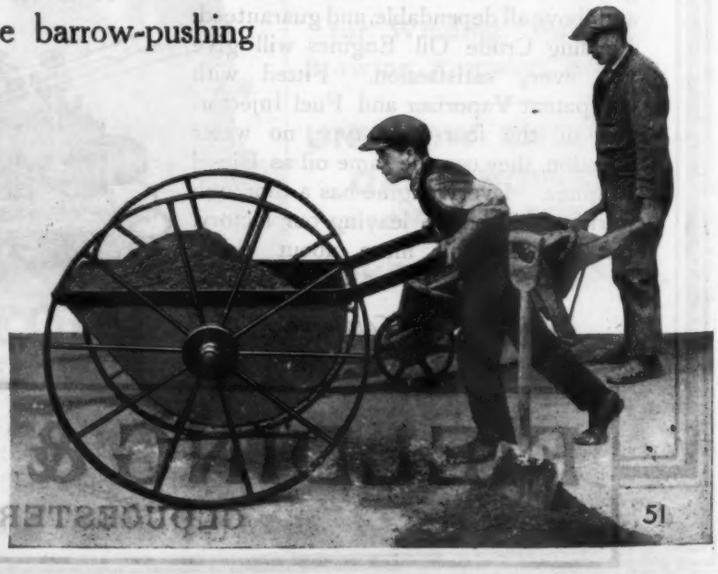
TIP-CARTS

which enable one boy to do the work of three barrow-pushing men, and which outwear several barrows.

Ransome "Rapid-Transit" Hand Tip-Carts are superseding barrows everywhere. Army Authorities in France ordered 600 for rush work. Contractors, builders, surveyors, etc., are snapping them up.

Capacity is 6 cu. ft.—or 3 or 4 times capacity of barrow. Yet because of large wheels and scientific balance which puts load on axle instead of handle, a fully loaded Ransome Tip-Cart is pushed as easily by a boy as a barrow is by a man. Handle can be fitted either end to make cart discharge at vertical or to turn completely over. Balance maintained unaided. Soundly built of steel; last for years. Selling like hot cakes.

Write to Dept. E. for Circular No. 11 and quotation.



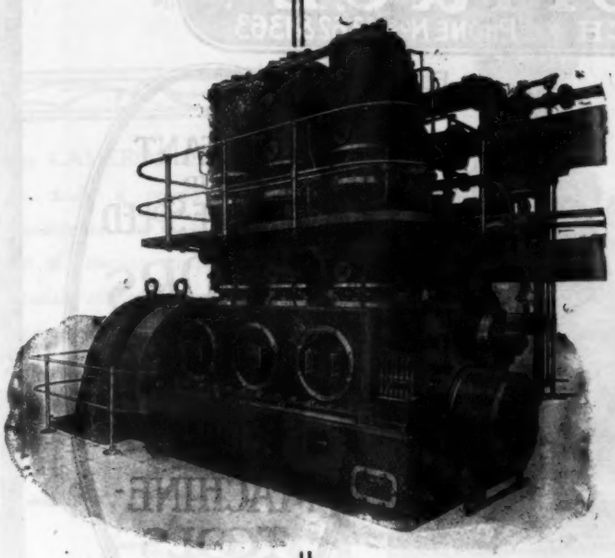
RANSOME-verMEHR MACHINERY CO. LTD.,

14-16, Grosvenor Gardens, London, S.W. 1.

Contractors to Governments, Public Bodies and those who appreciate that the Best is Cheapest. 3848

51

A MAXIMUM OUTPUT AT A MINIMUM COST.



¶ The 450 B.HP. "NATIONAL" Vertical Tandem Gas Engine illustrated, combines efficiency with reliability. It is constructed in a workshop specialising exclusively in this class of work.

¶ Here are some of the firms who decided upon "NATIONAL" Vertical Tandem Gas Engines as their form of motive power:—

Palmer's Shipbuilding & Iron Co., Ltd., Jarrow-on-Tyne.
Partington Steel & Iron Co., Ltd., Irlam, near Manchester.
Midland Coal, Coke and Iron Co., Ltd., Newcastle, Staffs.
Newton Chambers & Co., Ltd., Sheffield.
Wharncliffe Silkstone Colliery Co., Ltd., Tankersley, near Barnsley.
Baldwins Ltd., Landore, S.O.

¶ What reasons had they for installing "NATIONAL" Vertical Tandem Gas Engines?

¶ Because the "NATIONAL" Engine is the embodiment of sound design, first-class material and excellent workmanship.

¶ Because they knew the "NATIONAL" Engine would generate power for them at a cheaper cost than any other form of motive power available, and that by installing "NATIONAL" Engines they would have machines combining—EFFICIENCY, ECONOMY and RELIABILITY.

¶ Why not follow their example?

7049

THE NATIONAL GAS ENGINE COMPANY, LIMITED,

Telegrams: "NATIONAL," Ashton-under-Lyne.

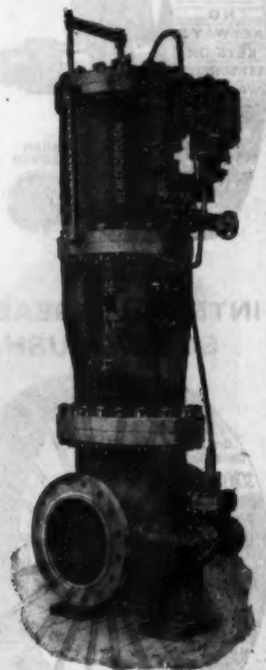
ASHTON-UNDER-LYNE.

Telephone: No. 428, Ashton-under-Lyne.

VALVES AND SLUICES

FOR ALL PURPOSES.

40 in. Electrically Operated Sluice Valve for Exhaust Steam.



550 m/m Valve constructed in Cast Steel for a working head of 1100 feet.

J. Blakeborough & Sons Ltd.

BRIGHOUSE, ENGLAND.

8284

LAURENCE, SCOTT & Co. LTD.

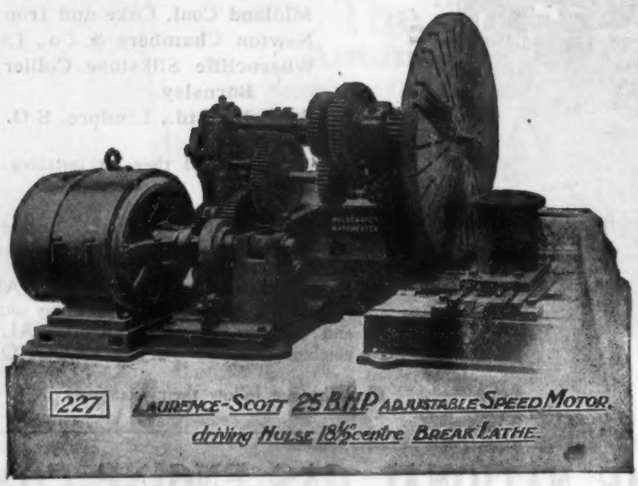
TEL. ADD:-GOTHIC NORWICH * NORWICH * 'PHONE Nos. 1362 & 1363

Established
·1883·

ADMIRALTY INSULATION STANDARD

L.S & Co.

·STUDY· CUSTOMERS SPECIAL REQUIREMENTS



227 LAURENCE-SCOTT 25 B.H.P ADJUSTABLE SPEED MOTOR. driving HULSE 18½" centre BREAK LATHE.

CONSTANT AND VARIABLE-SPEED MOTORS for DRIVING HEAVY MACHINE-TOOLS

Write To-Day for PAMPHLETS

8196

Write To-Day for PAMPHLETS

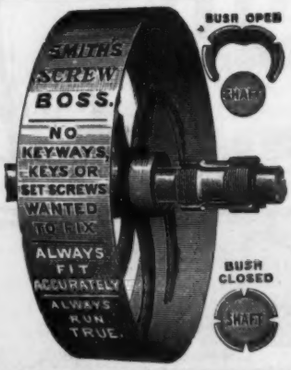
SMITH'S SCREW BOSS PULLEYS

SELF-FIXING. NO KEYS OR KEYWAYS.

TENS OF THOUSANDS IN USE.

THE PULLEY FOR MERCHANTS KEEPING STOCKS—BUSHES BEING INTERCHANGEABLE.

WITH INTERCHANGEABLE SCREW BUSH.



35, Queen Victoria Street, E.C.
LONDON.
Telephone ... ... 8531 City.

POWER TRANSMISSION A SPECIALITY.

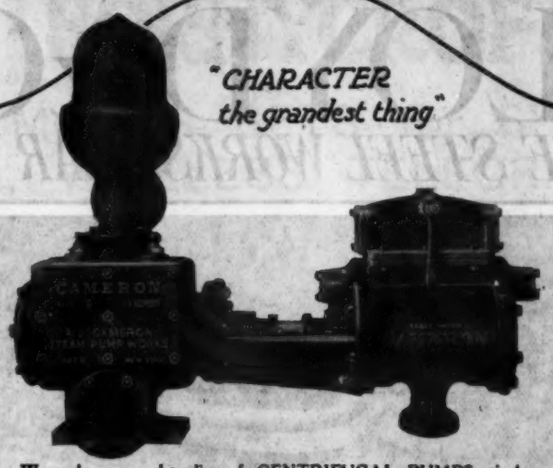
Illustrated Priced Catalogue post free on application.

SMITH & GRACE

SCREW BOSS PULLEY CO., LIMITED,
ENGINEERS
8566
THRAPSTON.

Telephone: No. 19 THRAPSTONE.
Telegrams: "GRACE, THRAPSTONE."

"CHARACTER
the grandest thing"



The CAMERON Steam Pump has made a record worthy of consideration by any prospective user of pumping equipment. It is especially adapted to suit the many requirements of the user. Strongly constructed and compact in design, with fewer working parts than any other make, it is certain in operation and reliable for continuous service.

The CAMERON Steam Pump is so constructed that while under full pressure of steam the suction pipe may be lifted out of the water, and the pump allowed to race without injury to the pump. The entire steam valve mechanism is enclosed and there are no arms or levers to break.

We make a complete line of CENTRIFUGAL PUMPS, single and multiple stage, Belt driven or direct connected to electric Motor or steam Turbine. PLUNGER and PISTON PUMPS, Horizontal and Vertical, steam or air driven, Vertical Sinking Pumps.
FULL PARTICULARS SENT ON RECEIPT OF REQUEST.

CAMERON PUMPS

INGERSOLL-RAND COMPANY Inc. in U.S.A.
165, Queen Victoria Street,
LONDON, E.C.4.
New York: 11, Broadway
Offices: The World Over

8170

Marine Auxiliaries

FEED WATER HEATERS.
FUEL OIL HEATERS.
COMPLETE DISTILLING PLANTS.
FILTERS.
STRAINERS.
LUBRICATING OIL COOLERS.

The Griscom-Russell Co.,
95, West Street, New York, U.S.A.
Cable Address: "Grispen, New York."

8486

Reilly Evaporator Submerged Type Composition Shell.

For England: W. Christie & Grey, Ltd., 4, Lloyd's Avenue, London, E.C. 3.
Telegraphic Address: "TYPHAGITOR." Telephone: AVENUE 1331.

F. H. LLOYD & Co., LTD

JAMES BRIDGE STEEL WORKS, NEAR WEDNESBURY.

Head Office:
James Bridge Steel Works,
WEDNESBURY.

London Office:
50, Queen Anne's Gate,
WESTMINSTER, S.W.1.

Branch Offices:
134, Deansgate,
MANCHESTER.
19, Waterloo Road,
NEWPORT, MON.
143, West Regent Street,
GLASGOW.

HAWSE PIPE FOR H.M.S. "AMPHION"

On Admiralty, Lloyds Register & Crown Agents for the Colonies Lists.

Telegrams:
STEEL, DARLASTON.
SAEPIUS, VIC. LONDON.

Telephone:
44 DARLASTON.
1361 VICTORIA.

STEEL CASTINGS

FROM 2 LBS. TO 20 TONS.

The quality of our Castings is the outcome of 40 years' experience. You can be supplied from open Hearth, or Tropenas Furnaces with all types of Castings which from start to finish have the benefit of a plant which has been kept up to date. Give us the privilege of quoting you.

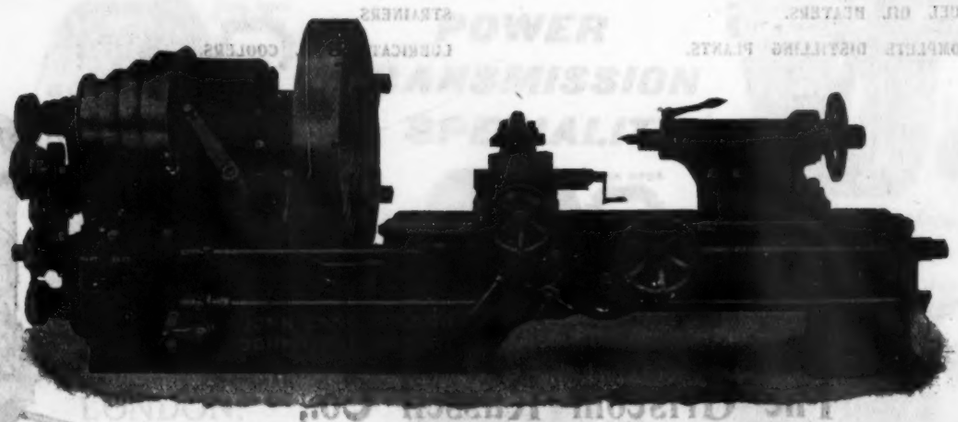
LANG'S RAPID REDUCTION LATHES

ARE MANUFACTURED IN THREE SIZES.

11 INCHES, 13 INCHES AND 16 INCHES CENTRE.

WE ARE EXHIBITING

MACHINE TOOL ENGINEERING EXHIBITION
MACHINERY IN MOTION
OLYMPIA
LONDON
SEPT 4-25



13 inches centre RAPID REDUCTION LATHE.

CATALOGUE ON APPLICATION. *VISITORS WELCOME.* 8167

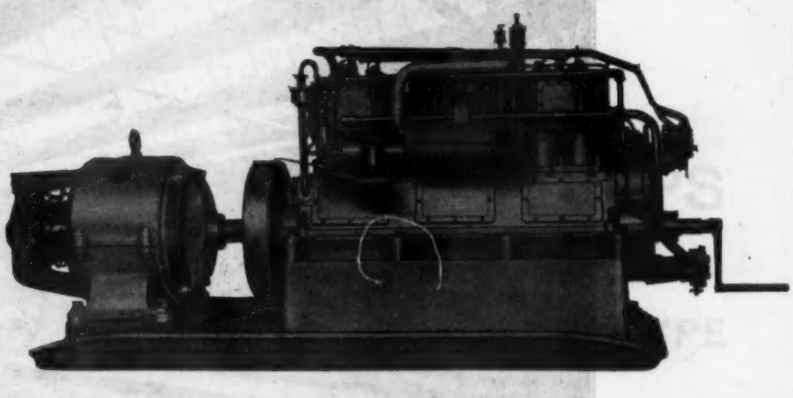
JOHN LANG & SONS, Lathe Manufacturers.

JOHNSTONE, NEAR GLASGOW.

THORNYCROFT

STATIONARY MOTOR SETS for SHIPS' LIGHTING, PUMPING, WIRELESS TELEGRAPHY, Etc.

The new Cunarder "Scythia" will be equipped with a Thornycroft c/8 type, 36/42 kw. Emergency Lighting Set, as illustrated.



Supplied to the CUNARD and other leading Lines for whom an independent emergency lighting equipment of unquestionable reliability is indispensable.

FULL PARTICULARS ON REQUEST.

JOHN I. THORNYCROFT & CO., LIMITED, 10, Grosvenor Place, LONDON, S.W. 1.

WORKS: BASINGSTOKE & SOUTHAMPTON.

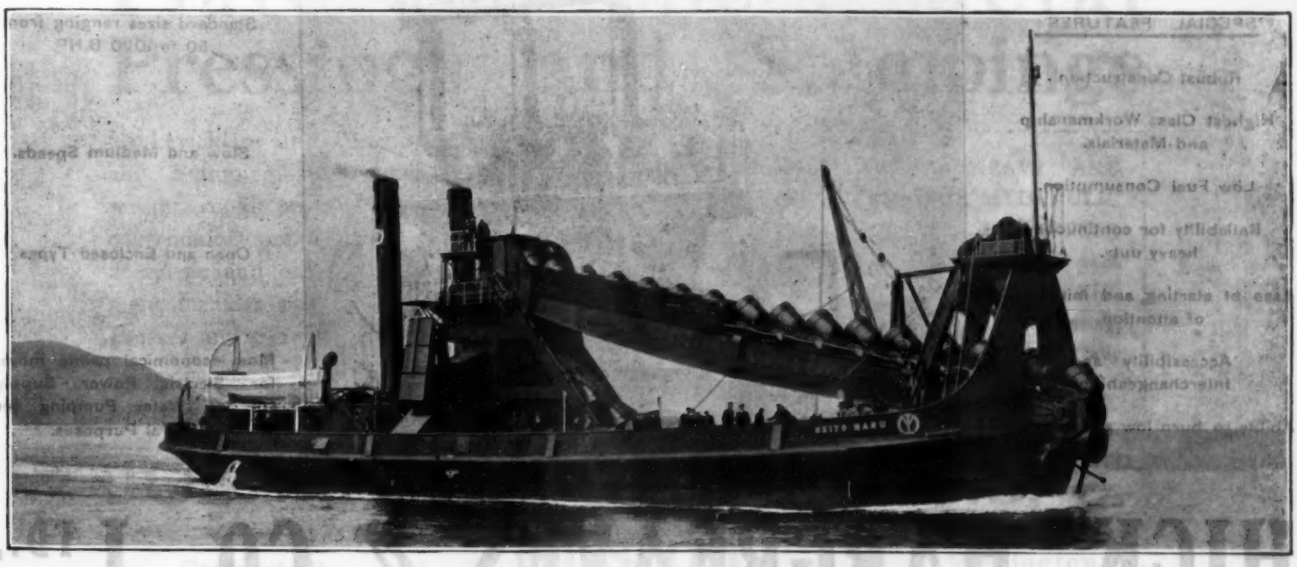
8949

DREDGING PLANT

Up to the Largest Dimensions and Capabilities.

Grand Prize at London Exhibition, 1909.
Gold Medal, Japan-British Exhibition, 1914.

Bow and Stern Well Centre and Side Ladder Bucket Barge Loading and Hopper-Dredgers, Suction Dredgers, Hydraulic and Mechanical Agitators, Discharge Pipes and Pontoons, Hopper Barges, Sewage Steamers, Caissons, Tugs, Ferries, Paddle and Screw Steamers.



7366

Delivered Complete or Shipped in Sections. ***Spare Gear and Renewals Supplied.***

FERGUSON BROTHERS (Port Glasgow), LTD.

SHIPBUILDERS AND ENGINEERS.

ON WAR OFFICE AND ADMIRALTY LISTS. ***NEWARK WORKS, PORT GLASGOW.*** *Tele. Address: DREDGER, PORT GLASGOW.*

JOHN BOOTH & SONS
BOLTON.

Warren Girder Roof for Tramway Shed 311 ft. long by 87 ft. wide. Note the entire absence of columns.

8600

STRUCTURAL STEEL WORK.

DIESEL OIL ENGINES

SPECIAL FEATURES:

Robust Construction.

Highest Class Workmanship and Materials.

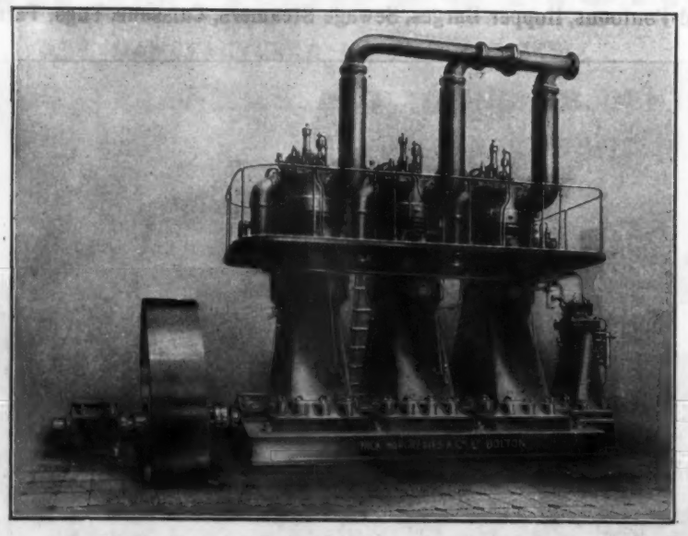
Low Fuel Consumption.

Reliability for continuous heavy duty.

Ease of starting and minimum of attention.

Accessibility and Interchangeability.

Ability to burn low grade fuels.



Standard sizes ranging from 50 to 1020 B.HP.

Slow and Medium Speeds.

Open and Enclosed Types.

Most economical prime mover for Electric Power Supply, Oil and Water Pumping and General Purposes.

Standard Three-Cylinder 510 B.HP. Open Type Engine.

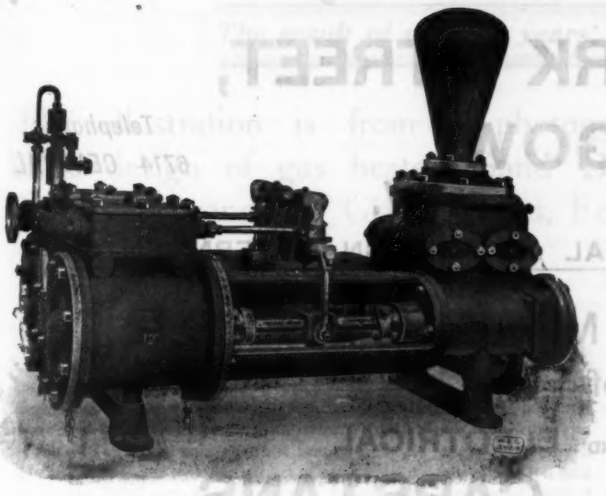
HICK, HARGREAVES & CO., LTD.,
BOLTON, ESTABLISHED 1832. ENGLAND.

7543

Telegraphic Addresses { "HICK, BOLTON," "UMSHAWVAPO, FLEET, LONDON." Telephone { Bolton—1373-4. London—8388 Central. LONDON OFFICE: 90, Temple Chambers, Temple Avenue, London, E.C. 4. Telegraphic Codes: ABC 5th Edition; A 1 (1888), Western Union (Universal Edition), Lieber's Standard.

Manufacturers of Corliss, Drop Valve, and Uniflow Steam Engines Diesel Oil Engines. Condensing Plant. Mill Gearing.

TANGYE



DUPLEX PUMPS

BUCKET OR RAM TYPE

FOR

ALL PURPOSES.

3670

TANGYES LTD., BIRMINGHAM.

3850

No. 411 BR

SANKEY

Plate and Sheet Metal Pressings and Stampings

Sankey Plate and Sheet Metal Pressings and Stampings are made any size or weight, rough or machined, single piece or combination pressed and welded by Oxy-acetylene and other processes. Our equipment includes 750-ton Hydraulic and other Presses and Stamps.

Send details of your requirements and we will quote you.

AEROPLANE PARTS. — HEAVY AND LIGHT STEEL STAMPINGS, HYDRAULIC STEEL PRESSINGS, PRESSED STEEL FOUNDRY LADLES, STEEL STORAGE BINS, SANKEY STEEL MOTOR WHEELS, SPECIAL STEEL SHEETS, for Engineering, Electrical and Hardware Trades (Hydraulically Flattened).

JOSEPH SANKEY & SONS, LTD.,

Telephone: Bilston 115 (5 *lines*). *Telegrams: "Sankey, Bilston."*

Bilston

Ettingshall
Manor Sheet Iron Works.

Albert Street Works and Bankfield Works.

Wellington
(Shropshire)
Hadley Castle Works.

7804

NAPIER BROTHERS, LIMITED,

130, HYDEPARK STREET,

Telegrams:
"WINDLASS, GLASGOW."

GLASGOW, W.

Telephone:
6714 CENTRAL.

Contractors to ADMIRALTY, COLONIAL AND FOREIGN GOVERNMENTS.

Patentees and Manufacturers

of

STEAM, HAND AND ELECTRICAL

WINDLASSES, CAPSTANS,
STEERING GEARS, WINCHES. 8049

Worm, Spur and Bevel Gear-cutting a Speciality.

BOVING & Co., Ltd.

WATER TURBINES

HYDRO-ELECTRIC POWER STATION EQUIPMENT

PIPE LINES

Single Stage High Pressure Pump.

CENTRIFUGAL PUMPS
for
Boiler Feed
Condensers,
Water Supply,
MINING, etc.

High Medium
and
Low Pressure
PUMPING PLANT

Head Office:—

56, KINGSWAY, LONDON, W.C.2

Telegrams—"JENORTEN PHONE, LONDON."

Telephone—HOLBORN 6420.

Works—STOKE-ON-TRENT.

Branches and Agents:—
MANCHESTER—R. Millet, 30, Cross Street.
GLASGOW—T. C. Lennard, 50, Wellington Street.
NEWCASTLE-ON-TYNE—J. Straker Wilson, 3, St. Nicholas Buildings.
BIRMINGHAM—L. Dunker, Norwich Union Chambers.
PARIS—68, Rue Caumartin.
JAPAN—No. 1, Yaesu Cho, 1 Chome Tokio.
Australasia—Bank of N.S.W. Chambers, Lambton Quay, Wellington
S. AMERICA—With, Walter & Co., 65, Rua General Camara, Rio-de-Janeiro.
CANADA—Boving Hydraulic & Eng. Co., Lindsay, Ont. 8063

PATENT SAND WASHERS AND DRYERS

The result of over 30 years' experience.

The illustration is from a photograph ot our latest design of gas heated Sand Dryer suitable for drying sand for Glass Works, Foundries, &c.

DESCRIPTION:

THE heat is developed from ring gas burners situated under each pan, the damp Sand is placed in the boot shown, from which it is carried up by the elevator buckets and dropped on to the bottom surface of the top hot pan round the surface of which it is pushed by arms attached to a central revolving spindle until it drops through a hole in the bottom of the pan on to the surface of the second pan, where it is again moved in the like manner by a further set of arms until it drops through a hole on to the third pan, this action and process being repeated until it finally falls out dried from a shute arranged just below the lowest pan.

HARDY & PADMORE, LTD.

WORCESTER - - - ENGLAND.

7700

ESTABLISHED 1814.

RAILWAY ROLLING STOCK

WE ARE MANUFACTURERS OF

PASSENGER COACHES, PULLMAN CARS, COVERED & OPEN GOODS WAGONS,

etc., etc.

CONTRACTORS TO

H.M. GOVERNMENT, INDIAN & STATE RAILWAYS,

etc., etc.

Drop Forgings and Stampings of every type and for every purpose.

CLAYTON & SHUTTLEWORTH LTD

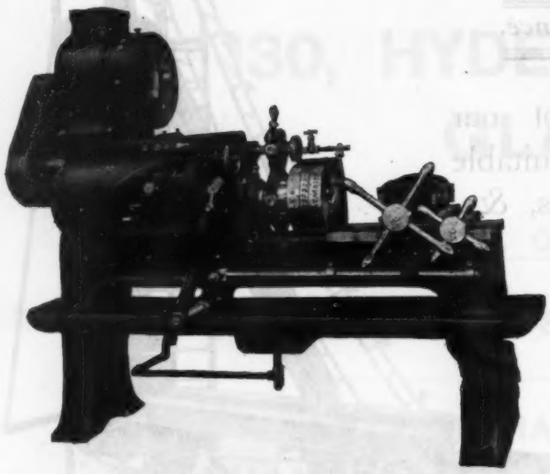
HEAD OFFICE STAMP END WORKS.

LINCOLN . . . ENGLAND

Telephone—42 & 43 Lincoln.
Telegrams—Claytons, Lincoln.

8270

Heap's Automatic Screwing Machines



Arranged for Direct Motor Drive.

These machines are made in all sizes with Single and Double Heads.

When desired they can be fitted with an All-Gear Head instead of the usual Cone Pulley. The drive can then be by Electric Motor as illustrated, or by Constant Speed Belt.

All these machines are fitted with our Patent Steel Head, which is the most simple and only mechanical Die-head on the market. Springs, with their attendant troubles or other delicate mechanisms, which can get clogged with dirt and the swarf inseparable from a Screwing Machine, do not enter into its construction in any way.

The Die-head opens automatically and the return motion of the carriage closes it ready for the next piece. There are no other levers to set.

If you have threading work to deal with send us particulars and we will offer you a suitable machine.

Copy of Catalogue will be posted free on request to all responsible firms.

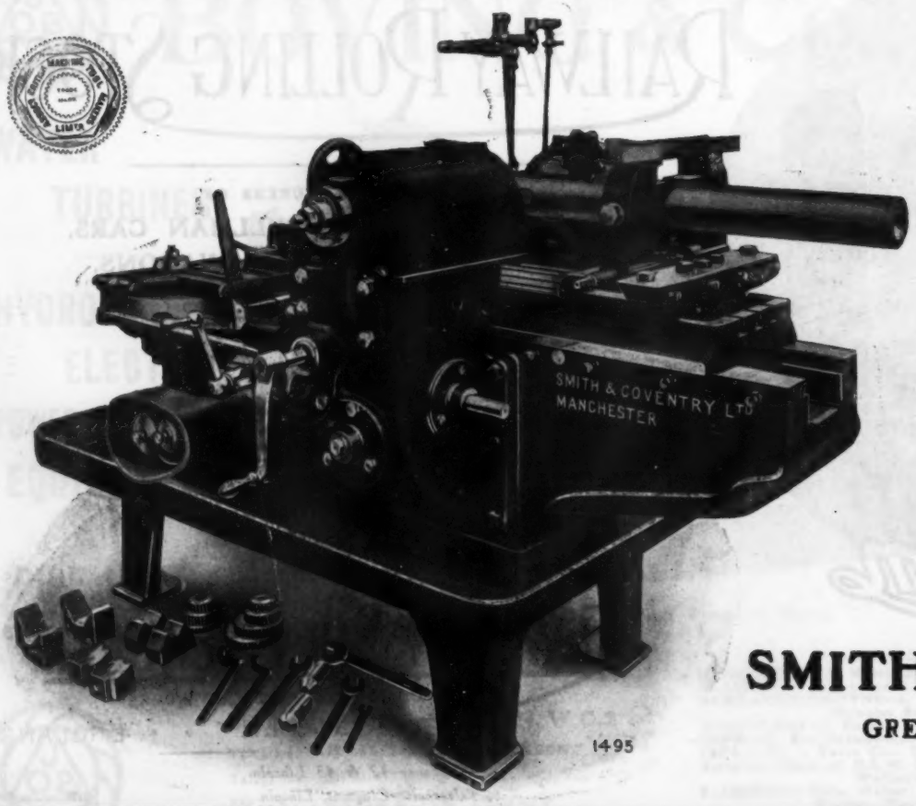
7518

JOSHUA HEAP & CO., LTD.,

ASHTON-UNDER-LYNE, ENGLAND.

S. & C. Patent

KEY-SEATING AND MORTICING MACHINE



1495

WE ALSO MANUFACTURE:

S. & C. Patent
HORIZONTAL MILLING MACHINES.

RELIEVING LATHE.

BRASS FINISHERS' LATHE (Cooper's Patent).

BEVEL GEAR PLANING MACHINES (Robey-Smith and S. & C. Patents).

NEW PLANING MACHINES (Bateman's Patent).

SENSITIVE DRILLING MACHINES.

BROACHING MACHINES.

SEND US YOUR REQUIREMENTS AND WE WILL QUOTE YOU.

We are also Sole Manufacturers of
S. & C. "LIGHTNING" TAPPERS (Pearns' Patent).

SMITH & COVENTRY LTD.,

GRESLEY IRON WORKS,

MANCHESTER.

AVERY

AVERY'S BRINELL HARDNESS TESTER

The only Brinell Hardness Tester embodying the weighing lever knife-edge and bearing principle.

Sensitive to increments of load of 1 kilo.

Calibration obtainable by a dead load of 3000 kilos.

No calculated load is employed.

"Brinelling" on an Avery Machine ensures a consistent accuracy unobtainable with any other design.

7983

W. & T. AVERY Ltd
SOHO FOUNDRY
BIRMINGHAM, ENGLAND.

Ad. 369.

EWART CHAINBELT Co Ltd DERBY.

CHAINS WHEELS BUCKETS
FOR
CONVEYORS AND ELEVATORS.

GOVERNING DIRECTOR: MAJOR SIR GORDON LEY, BART.

DIRECTORS —
H. M. GRAY. E. N. WOOD
IAN. F. PANTON

TECHNICAL DIRECTOR & MANAGER
W. H. ATHERTON MSc., M.I.M.E.
SECRETARY: ALEXANDER LANGLANDS.

TELEGRAMS "CHAINBELT" DERBY
TELEPHONE DERBY 139
ESTABLISHED 1889

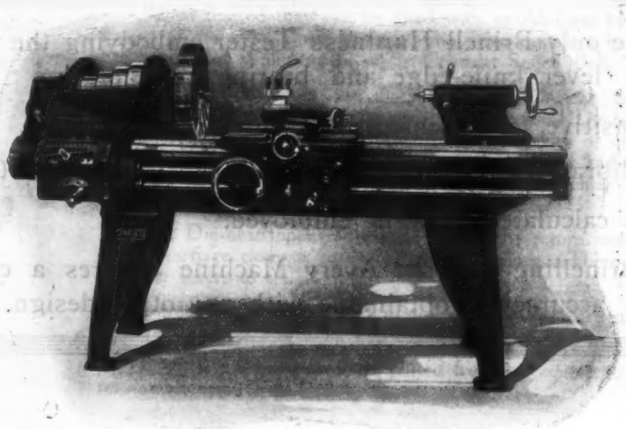
8″–9″ Centre, Self-acting, Sliding, Surfacing and Screw-cutting Precision-Lathes, Style "OHIO"

With V-Bed, gear box, front-shaft and hollow spindle.

WITH OR WITHOUT GAP.

High-Class Machine Tools.

PRECISION LATHES
PLANING MACHINES
SHAPING MACHINES
AUTOMATIC MACHINES
FOR ALL CLASS OF WORK.



Address Enquiries:—MACHINE TOOL DEPT.,

COLLEY ENGINEERING & MACHINERY CO.,

CLUN HOUSE, 17, SURREY STREET, STRAND, LONDON, W.C.2.

8126

PARTINGTON STEEL & IRON COMPANY LTD

VICKERS-PETTER

Semi-Diesel Crude Oil Engines.

INDUSTRIAL AND MARINE.

Design perfected by years of experience and development.

Sizes
10 to 450 B.HP.

When you buy an engine for your factory you think a great deal of a difference of £20 in the first cost.

But do you consider that a breakdown may cost you ten times that amount?

Buy an engine that does not break down—an engine with a history—which has already satisfied thousands of users.

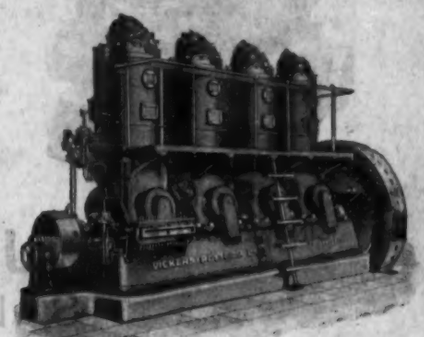
The VICKERS-PETTER Semi-Diesel Crude Oil Engine is the best oil engine on the market.

The best is cheapest.

General Sales Offices:

VICKERS - PETTERS Ltd.,
117-123, Gt. Portland Street, LONDON, W.
Works:—IPSWICH, ENGLAND.

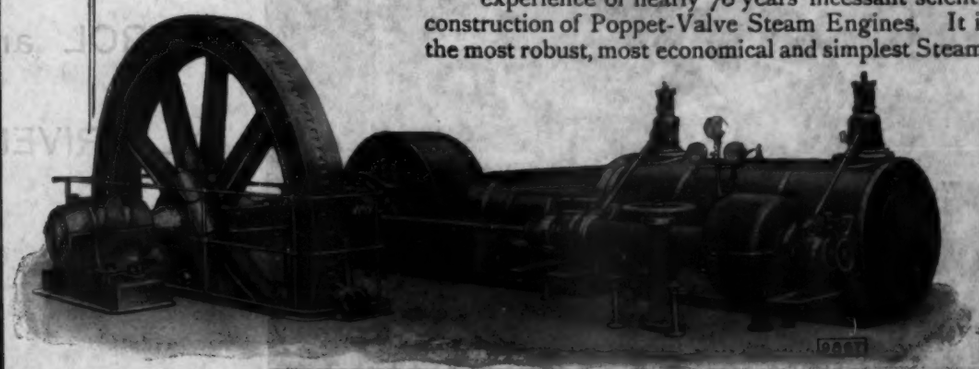
Over
150,000
Horse Power
Sold.



SULZER

UNIFLOW STEAM ENGINES

THE Sulzer Uniflow Steam Engine represents the accumulated experience of nearly 70 years' incessant scientific research in the construction of Poppet-Valve Steam Engines. It is without question the most robust, most economical and simplest Steam Engine available.



SALIENT FEATURES.

Suitability for Highest Steam Temperatures.

Low consumption of Steam and Lubricating Oil.

Absolute tightness of steam admission valves.

Excellent Regulation.

Small requirements of space, &c.

BUILT IN UNITS
from 100 to 10,000 B.HP.

SULZER

SULZER BROTHERS,
31, Bedford Sq., London, W.C.1.

PUMPS

FOR

ALL PURPOSES.

SINGLE RAM PUMP.

PUNCHING

and

SHEARING

MACHINES.

DOUBLE RAM PUMP.

JOHN CAMERON LTD.,

SALFORD, MANCHESTER.

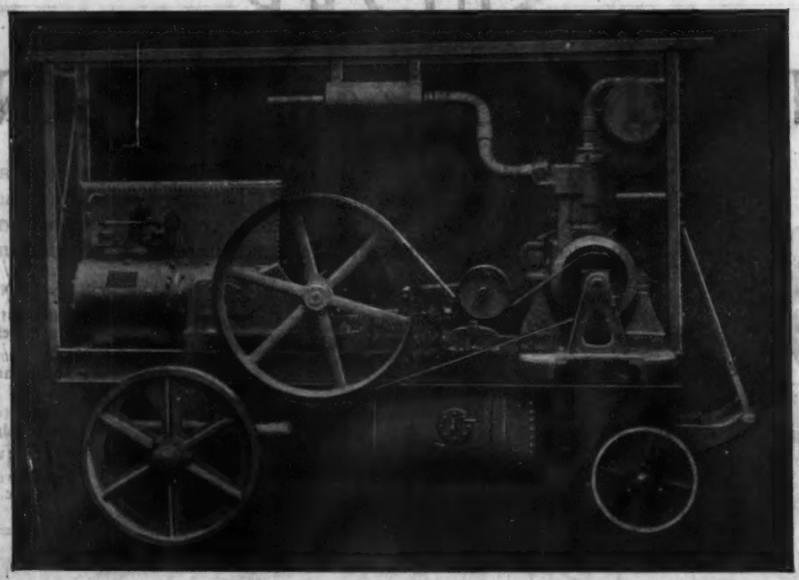
Telegrams: "ORIGINAL, MANCHESTER." Code—5th Edition, A B C. Telephone: 2002 CENTRAL.

AIR COMPRESSORS

Over 300 Styles and Sizes of Compressors—Modern in Every Detail. Fitted with "Simplate" Flat Disc Indestructible Valves.

BELT, STEAM,

ELECTRIC,



PETROL and

OIL DRIVEN.

Portable Petrol-driven Air Compressor, capacity 107 cubic ft. free air per minute, 100 lbs. working air pressure. Can be furnished in large or small sizes.

WRITE FOR PARTICULARS:

THE CONSOLIDATED PNEUMATIC TOOL CO., LTD.

Head Offices: EGYPTIAN HOUSE, 170, PICCADILLY, LONDON, W. 1.

WORKS: FRASERBURGH, SCOTLAND. Telegrams:— CAULKING, PICCY, LONDON. BRANCHES ALL OVER THE WORLD.

WRITE FOR OUR LATEST ILLUSTRATED CATALOGUE, No. 1108. MENTION "ENGINEERING."

"MARSHALL"

HUNDREDS OF THESE ROLLERS ARE IN USE. MADE IN WEIGHTS 6 TO 16 TONS. SIMPLE & COMPOUND TYPES.

ROAD ROLLERS

ROAD SCARIFIERS

PATENT ANTI-INCRUSTATION FIREBOX SUPPLIED. NO EXTRA COST.

1919

ENGINES FITTED WITH CONVERTIBLE GEAR, WATER SPRAYS, &c., TO MEET ALL USUAL REQUIREMENTS.

Stand No. 237 ROYAL SHOW DARLINGTON.

MARSHALL, SONS & Co., LTD., GAINSBOROUGH.

By Appointment.

CARRON

CARRON Cooking Appliances *(for Coal, Gas, Steam, or Electricity)* installed in the leading Industrial Canteens, Hospitals, Asylums, Workhouses, Hotels, Restaurants, Hydros, Clubs, Mansions, etc., throughout the Kingdom.

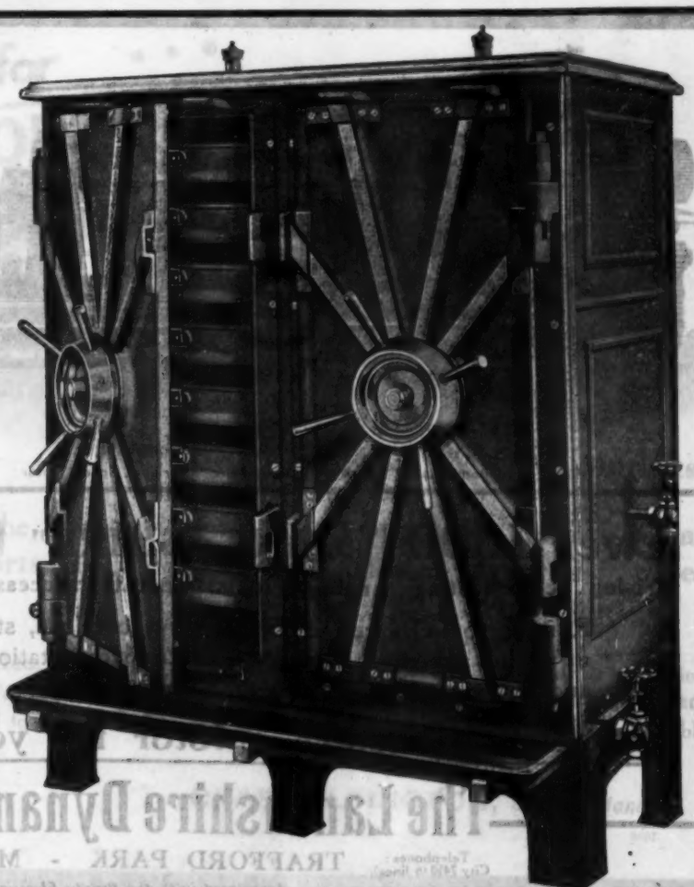


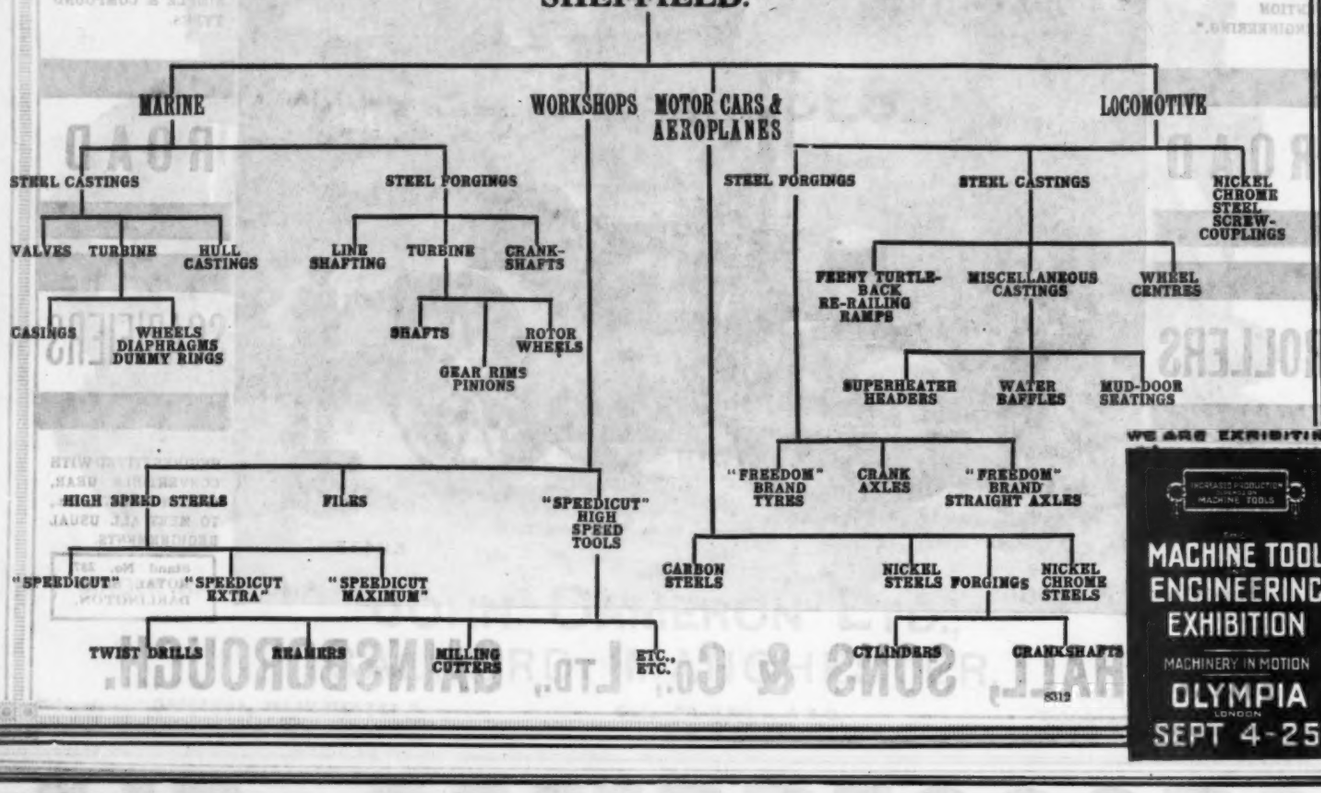
Illustration shows BATTERY OF STEAMING OVENS. Made in various sizes, each body being in one casting, and not being built up in sections, there is no risk of joints giving way under pressure. Doors are fitted with rubber packing, and the locking bolts are operated by a cam motion in centre. Ovens are sent out complete with galvanized iron trays, stool, drip trough, panelled casing, valves, etc.

¶ The Company are always pleased to specify for any style, size, or combination of Cooking Apparatus on receipt of plans or particulars, or to offer suggestions and submit drawings for alterations or extensions. No. 12G List post free.

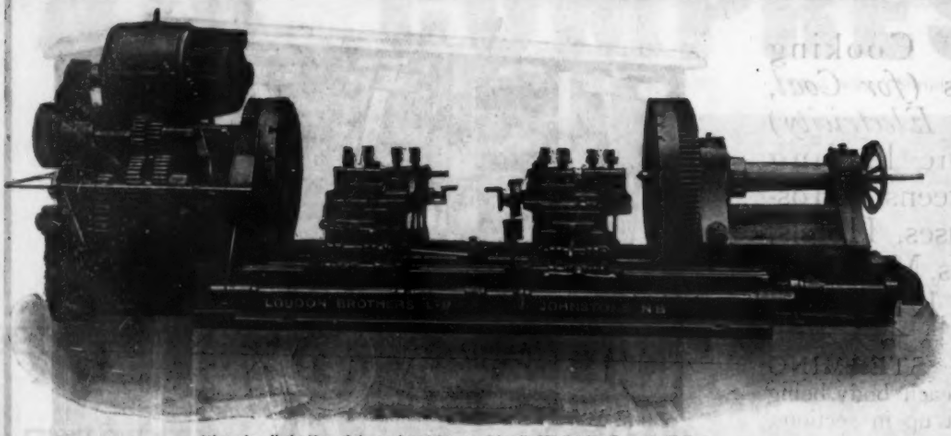
CARRON COMPANY Works: CARRON, STIRLINGSHIRE. Branch Works: Phœnix Foundry, SHEFFIELD.

Showrooms—LONDON: 15 Upper Thames St., E.C.4, and 50 Berners St., W.1. LIVERPOOL: Redeross St. GLASGOW: Buchanan St. EDINBURGH: George St. BRISTOL: Victoria St. NEWCASTLE-ON-TYNE: Prudhoe St. BIRMINGHAM: Corporation St.

THOS. FIRTH & SONS, LTD.
SHEFFIELD.



WE ARE EXHIBITING
INCREASED PRODUCTION THROUGH MACHINE TOOLS
MACHINE TOOL ENGINEERING EXHIBITION
MACHINERY IN MOTION
OLYMPIA
LONDON
SEPT 4-25



"Loudon" Lathe driven by "Lancashire" Variable Speed Motor.

LDM LANCASHIRE

Proof of Soundness.

Over 1000 "LANCASHIRE" MOTORS of standard construction,

driving reciprocating machine tools, operate successfully on the following cycle:—

Run up to full speed under load and overload, stop, run up to full speed with reversed direction of rotation, stop, and repeat cycle, with no pause between cycles } 30 to 400 cycles per hour.

Buy a "Lancashire" Motor for your drive——It is reliable.

The Lancashire Dynamo & Motor Co. Ltd.

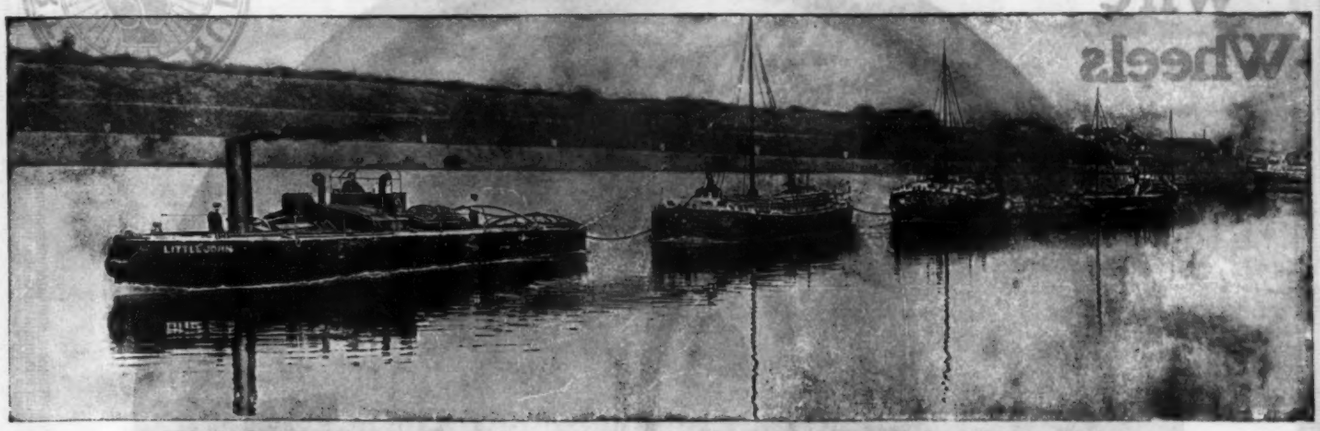
Telephones: City 7450 (6 lines). TRAFFORD PARK - MANCHESTER. Telegrams and Cables: Ironclad, Manchester. 8804

Associated with the Crypto Electrical Co., Ltd. Willesden

POWERFUL TWIN-SCREW SHALLOW DRAUGHT TUG

built by

YARROW & CO., Ltd., Glasgow.



The above represents a twin-screw Shallow Draught Tug, length 80 ft., beam 14 ft. 6 ins., draught 22 ins., propelled by screws working in tunnels fitted with YARROW'S PATENT BALANCED HINGED FLAP, by means of which considerable increase of speed is secured without additional power or cost, and the maximum efficiency under all conditions of load is obtained.

Messrs. YARROW construct fast Passenger and Commercial Vessels, Shallow Draught Steamers, Tugs, &c., propelled by Sternwheels, Side Wheels, or Screws working in Tunnels fitted with Yarrow's Patent Balanced Hinged Flap.

REPAIRS ON PACIFIC COAST

by YARROWS, Limited, Victoria, British Columbia, Shipbuilders, Ship Repairers and Engineers.

7770

SITES for ... WORKS, FACTORIES WAREHOUSES, etc. ADJOINING THE G.W.R.

Numerous areas of land, admirably situated.

Good Water Supplies - - - - - - - - Proximity to Good Markets.

This Railway is connected with some of the largest Steam, Anthracite, and House Coal Fields, many of the Principal Ports, and important and extensive Iron and Steel Producing Centres.

Information as to **Suitable Sites, Siding Facilities, Conveyance Rates, &c.,** will be readily afforded on application to Mr. C. A. ROBERTS, Chief Goods Manager, Paddington Station, W. 2, to whom **Owners** and **Agents** of **Land** and **Premises** for **Sale** or to be **Let** are invited to send particulars for insertion in the **Register** which is kept to enable information to be furnished to parties requiring Sites, &c.

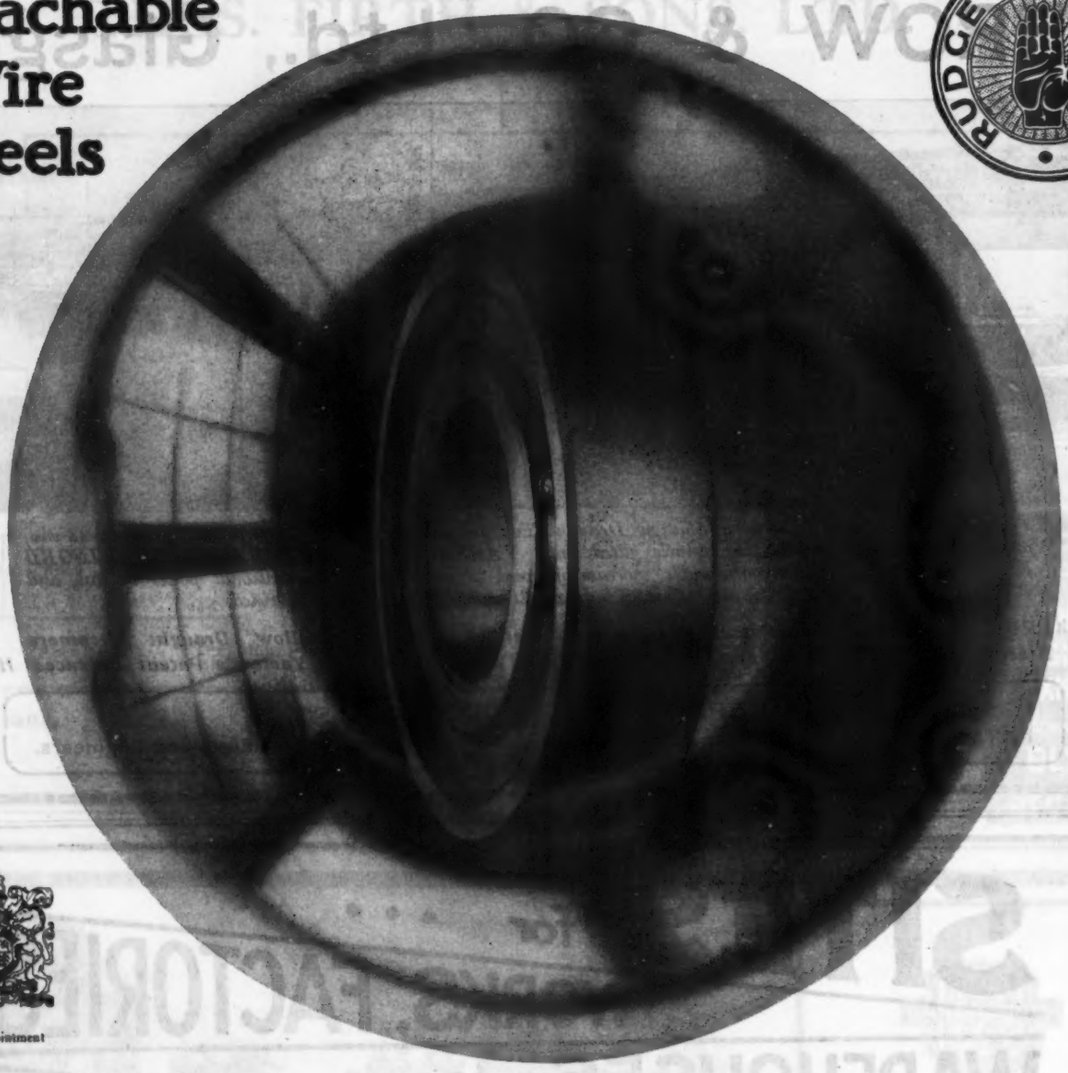
CHAS. ALDINGTON, *General Manager.*

G.W.R., Paddington Station, W. 2.

8697

Detachable Wire Wheels

RUDGE-WHITWORTH



By Appointment

Steel Balls & Ball Bearings

Rudge-Whitworth Ltd.
Coventry
& Sparkhill,
Birmingham.

Agent for France: Mr E. Meunier, 34 Rue Pergolèse, Paris.

"Magnet," Manchester
"Orders," Cannon, London.

Electromotors Limited

OPENSHAW:

London 49 Queen Victoria St. E.C.

Manufacturers of
Continuous Current

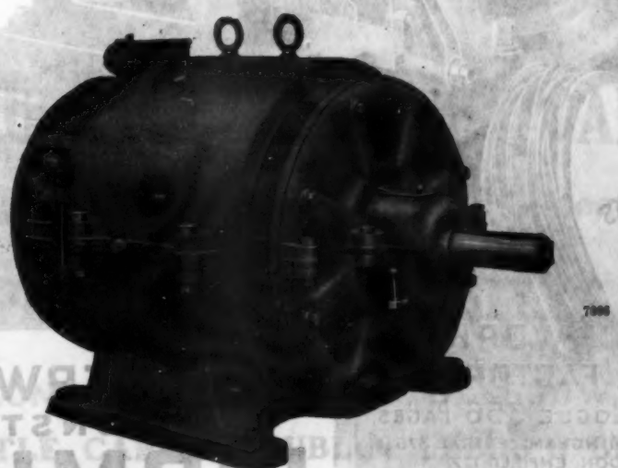
MOTORS

for driving
all classes of machinery

As specialists in the manufacture of these machines, we are able to offer you a machine that is reliable in operation, handsome in appearance, and accepted by all Government Departments and the leading engineers and shipbuilders.

Examine the details:—Admiralty pattern bearings with two oil rings to each, shaft ground all over, box brushes, commutator of large diameter and for long wear, swing doors and substantial terminal box are typical of the care bestowed on the whole construction.

OF HIGH-CLASS DESIGN
AT COMPETITIVE PRICES



TAYLOR & CHALLEN LTD

PRESSES

28" DIA. 8" DEEP

25" DIA. 10" DEEP

No 962
TOGGLE DRAWING
PRESS
PAGE 21.
1916 CATALOGUE

LARGEST
ROUND CUPS
FROM
42" DIAM: BLANK.

PRODUCING A MOTOR
CAR RADIATOR CASING
AT ONE STROKE IN
12 SECONDS.

FOR EQUIPMENT OF
MINTS, MUNITION WORKS
AND HARDWARE FACTORIES
REFER TO 1916 CATALOGUE 356 PAGES

TELEPHONES { BIRMINGHAM, CENTRAL 376
LONDON, ENFIELD 177.
TELEGRAMS. "DERWENT, BIRMINGHAM."

DERWENT WORKS
CONSTITUTION HILL.
BIRMINGHAM

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires & Strands.
Aluminium Wires & Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steel Work.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

BUY from the B.I.

REMEMBER, when you buy B.I. products that you are buying not only finished materials of the highest class, but also materials which have acquired in their passage through our hands something of the Ego, Essence, Pith, Heart or Soul—call it what you will—of the B.I.; that behind them stands a great Company proud of its reputation and determined to maintain it.

6341

BRITISH INSULATED & HELSBY CABLES LTD.,

Cablemakers and Electrical Engineers,

Works: PRESCOT, LANCASHIRE, and HELSBY, nr. WARRINGTON.

Branch Offices in LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

TRADE MARK

A. W.
ENGINEERS
SMALL TOOLS

ARE FAMOUS FOR THEIR ACCURACY AND ENDURANCE.

MILLING CUTTERS,
HOBS AND BROACHES,
TWIST DRILLS, GAUGES,
SCREWING APPARATUS,
ETC., ETC.

Made from the famous A. W. Brands of High Speed and Carbon Tool Steel.

Sir W. G. ARMSTRONG, WHITWORTH & Co., LTD.,

CENTRAL COMMERCIAL DEPT.: 8195

3, WOODSTOCK STREET, OXFORD STREET, LONDON, W. 1.

Telegrams: "Arwhitcoy, Wesdo, London." Telephone: Mayfair 189 & 190.

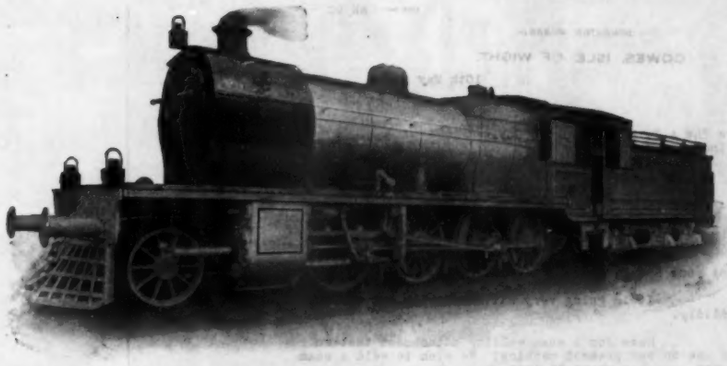
DISTRICT OFFICES:

BIRMINGHAM: 158-161, Great Charles Street.
MANCHESTER: 5, John Dalton Street.
GLASGOW: 137A, St. Vincent Street.
LEEDS: Pearl Chambers, East Parade.
NEWCASTLE-ON-TYNE: Pilgrim House, Pilgrim Street.

BEARDMORE

FOR

BETTER TRANSPORT



MAIN LINE LOCOMOTIVE, RECENTLY BUILT AT DALMUIR—
ONE OF A BIG CONTRACT FOR THE EAST INDIAN RAILWAYS.

WILLIAM BEARDMORE & CO. LTD.

PARKHEAD STEEL WORKS,

GLASGOW.

8058

LOCOMOTIVES

LONDON OFFICE.....36, VICTORIA ST., S.W.1.

"A-I" Electric Welders

applied to " SKOOTAMOTA" manufacturing this time.

ALL COMMUNICATIONS TO BE ADDRESSED TO THE COMPANY AND NOT TO INDIVIDUALS.

Directors
Charles Joseph Pood
Managing Director:
Gilbert Campling
Directors
A. Warne Gibbins.
O. H. W. Temple. F.W.Bennett
Robert Brown, O.B.E.
Secretary:
G.P.Goldin
F. V. Harrison

GILBERT CAMPLING LIMITED

Codes: A.B.C. 5th Edition
Liebers Five Letter Code.
Marconi's International

Telephone:
COWES 21.

Telegrams:
"Skootamota, Cowes"

Your Ref.
Our Ref. WH/DC

SOMERTON WORKS:-
COWES, ISLE OF WIGHT.

Sole Manufacturers of the Skootamota

Registered & Registered Offices:
22 OLD JEWRY, LONDON, E.C.
Telephone: BANK 4[illegible]

London Showrooms & Sales Dept:
1 ALBEMARLE ST., LONDON, W.1
Telephone: REGENT 4[illegible]
GERRARD 4[illegible]
Telegrams:
"SKOOTAMOTA, PICCY, LONDON"

Southwood Works:
S. CROYDON, SURREY.
Telephone: CROYDON 4[illegible]
Telegrams: SKOOTAMOTA, CROYDON

10th May 1920

Messrs The A.I. Manufacturing Coy.
Industry Works,
Sunbridge Road,
Bradford

Dear Sirs,-

We have at present installed at these works one of your No. 3. A.I. Spot Welders.

It is going very satisfactorily and working splendidly.

Have you a seam welding attachment that we could use on our present machine? We wish to weld a seam in a box, roughly about 8" deep.

If you have such an attachment, will you please quote price, delivery etc.,

Yours faithfully.
For Gilbert Campling Limited.

Works Manager.

A-I in name

and assuredly

A. I in quality.

We have the Attachments they require—good output enables them to get extra unanticipated service from the Plant.

Made by

A-I MANUFACTURING CO, (Dept. D), Industry Works, Sunbridge Road, BRADFORD.

Telephones : 5152, 5153.

Telegrams : "Patterns," Bradford.

London Office

J. COULTON (Representative) (Dept. D)
Bevois House, 28, Basinghall Street, E.C. 2.
'Phone—5979 London Wall. 'Grams—"Cycoultond, Ave," London.

Agencies in Foreign Countries.

Agencies (Great Britain)

RD. JOHNSON, CLAPHAM & MORRIS, Ltd. (Dept. D)
24 and 26, Lever Street, MANCHESTER.
'Phone—1120 Central (9 direct lines). 'Grams—"Metallicas," Manchester.

8409 **PERKIN & CO., Ltd. (Dept. D)**
Junction Works, Whitehall Road, LEEDS.
Telephone—26805. Telegrams—"Perco," Leeds.

TURBO-ELECTRIC PLANT.

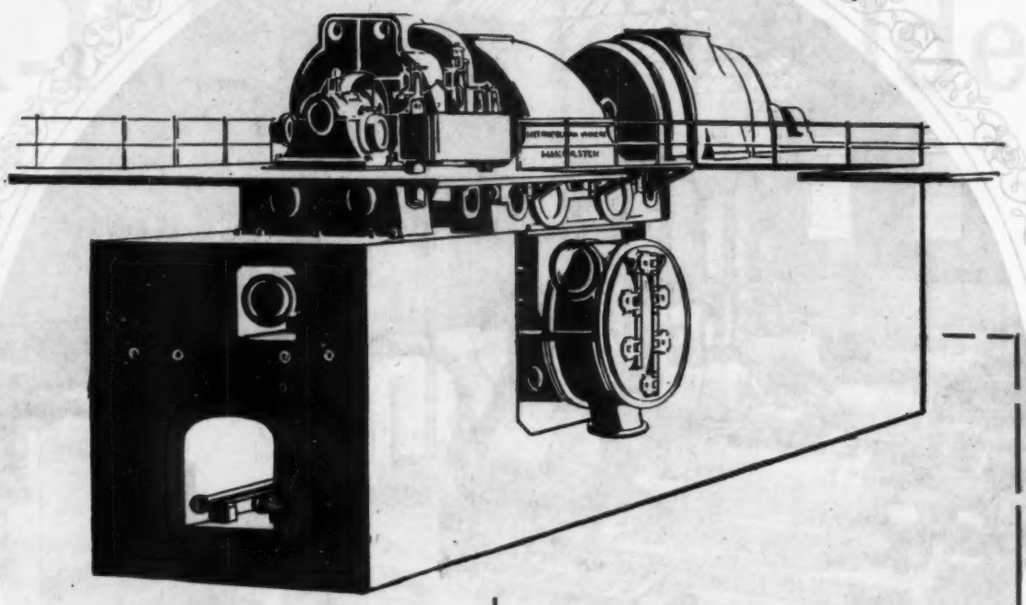
MANUFACTURE of Electrical Plant and Apparatus is specialised at the several works of the Company:—Dick, Kerr Works, Preston; Ordnance Works, Coventry; Phœnix Works, Bradford; Siemens' Works, Stafford; and Willans' Works, Rugby.

The
ENGLISH-ELECTRIC-COMPANY
LIMITED

QUEENS-HOUSE
Kingsway-London-W.C.2

Telegrams: "ENELECTICO, WEST. CENT, LONDON." | Telephone: HOLBORN 830. | Cables: "ENELECTICO, LONDON." 9664

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.



BEST SERVICE

— and —

LOWEST STEAM CONSUMPTIONS

with

Metropolitan-Vickers

STEAM TURBINES

(Rateau type).

The following improvements are now embodied in the original design

Patent

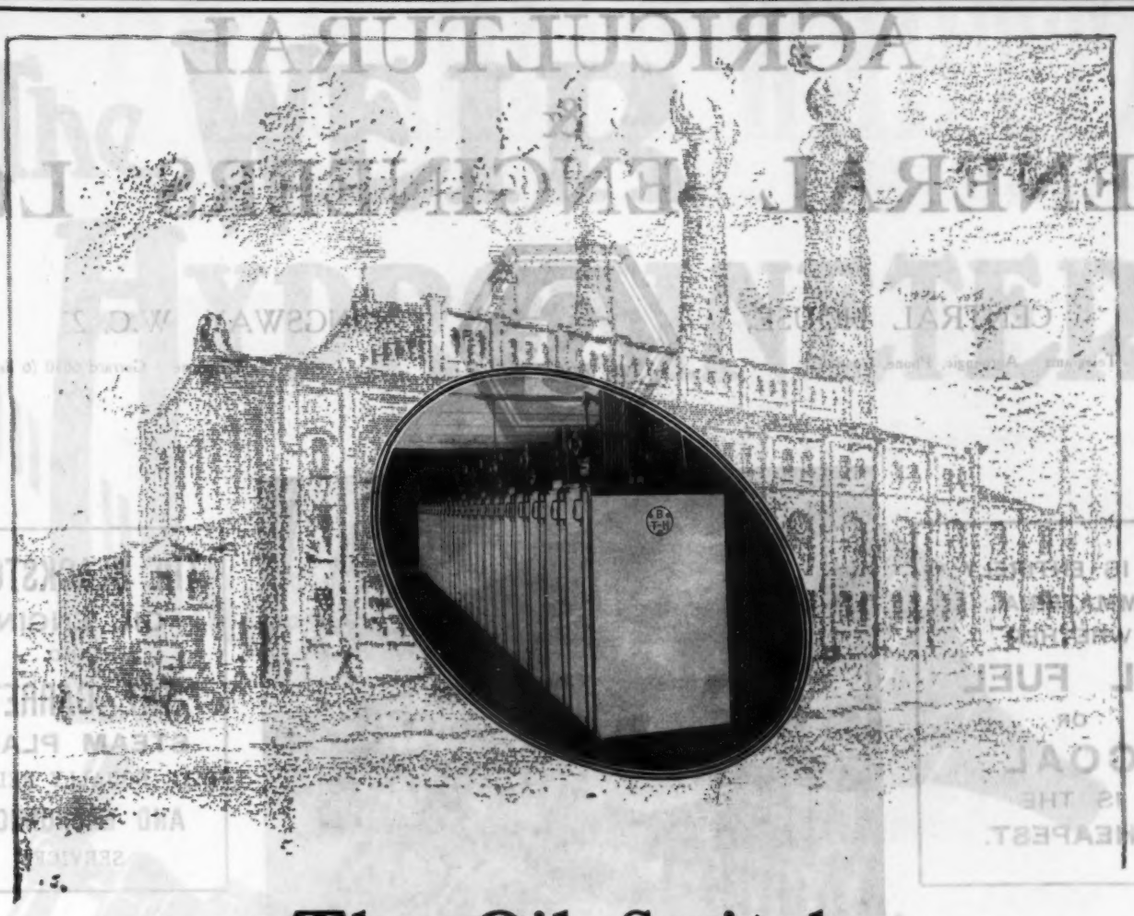
FEED HEATING,
NOZZLE BOXES,
EXHAUST BLADING

Up to 50,000 Kw.
in One Cylinder.

Forward Your Enquiries to TURBINE DEPARTMENT.

7931

TRAFFORD PARK MANCHESTER



The Oil Switch
for
Large Power Stations.

B T-H

Form H. Motor Operated Oil Switch.

This Oil Switch, of proved reliability, has a record of service unequalled by any other switch in the world, 479 being installed in some of the largest Generating Stations in the United Kingdom alone.

To enable prompt deliveries of extra high tension Switchgear to be made, Form H. Oil Switches are carried in stock.

Write for illustrated list EG. 256 on Form H. Oil Switches.

The British Thomson-Houston Co. Ltd.

Electrical Engineers and Manufacturers,

Head Office and Works - - - Rugby, England.

8220

AGRICULTURAL & GENERAL ENGINEERS Ltd.

CENTRAL HOUSE, KINGSWAY, W.C. 2.

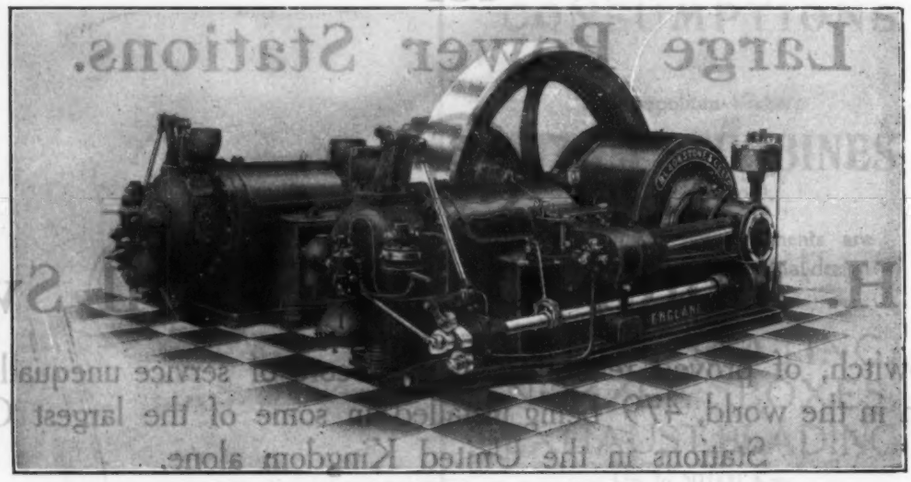
Telegrams: Agroengic, Phone, London. Telephone: Gerrard 6850 (6 lines).

IT IS ENTIRELY IMMATERIAL WHETHER **OIL FUEL** OR **COAL** IS THE **CHEAPEST.**

THE "GARRETT" SUPERHEATED STEAM ENGINE.

"THE BLACKSTONE" OIL ENGINE AND THE GARRETT" STEAM PLANT GIVE EQUALLY RELIABLE AND ECONOMICAL SERVICE.

SUITABLE FOR FACTORIES, MILLS AND ELECTRIC POWER STATIONS.



THE "BLACKSTONE" OIL ENGINE.

FULL RANGE OF SIZES UP TO **520 B.HP.** CONTINUOUS WORKING LOAD.

The Garrett Power Plant and Blackstone Oil Engine will be exhibited on our STAND No. 184, at the ROYAL SHOW, DARLINGTON, JUNE 29th—JULY 3rd.

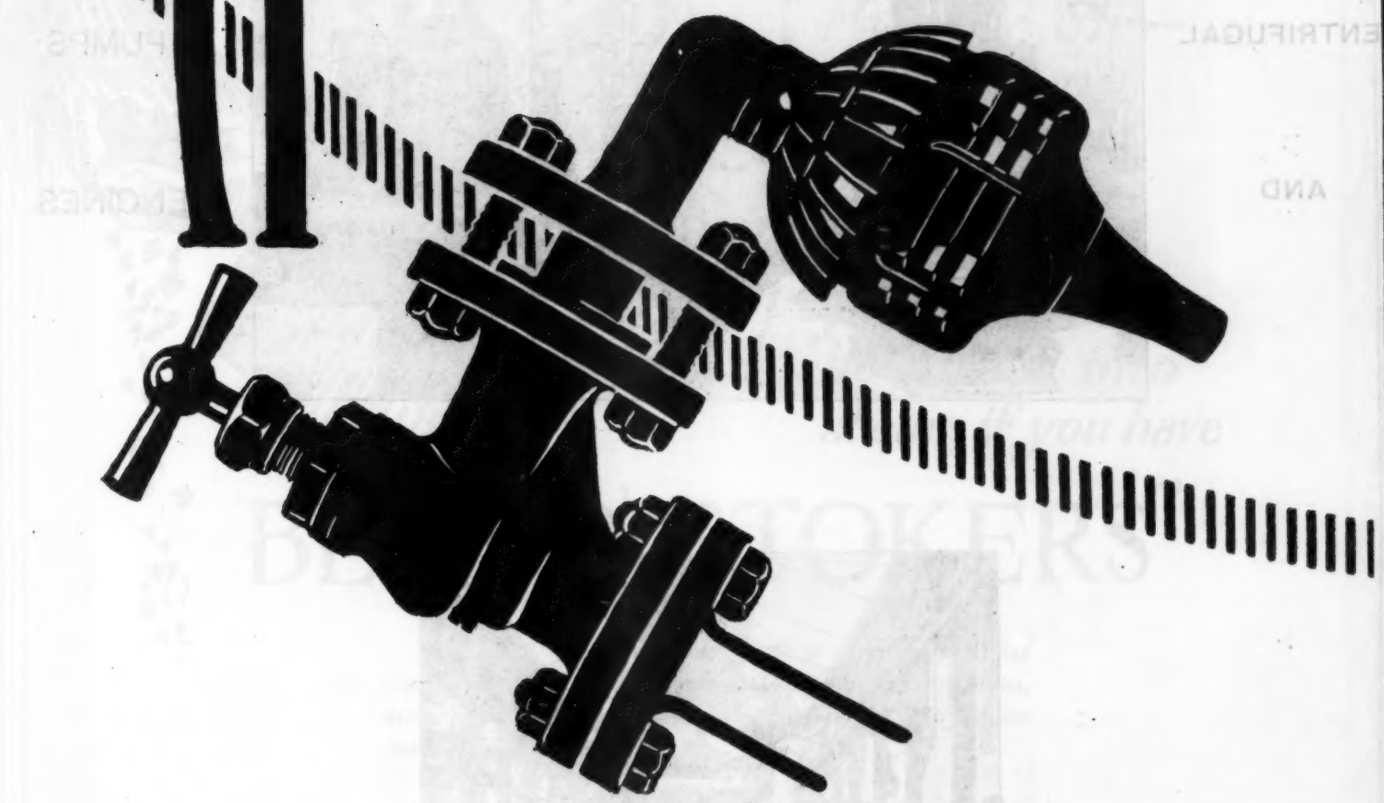
8488

ASSOCIATED FIRMS:

AVELING & PORTER, Ltd.	ROCHESTER	CLARKE'S CRANK & FORGE CO., Ltd.	LINCOLN.
BARFORD & PERKINS, Ltd.	PETERBOROUGH.	RICHARD GARRETT & SONS, Ltd.	LEISTON.
E. H. BENTALL & CO., Ltd.	HEYBRIDGE.	J. & F. HOWARD, Ltd.	BEDFORD.
BLACKSTONE & CO., Ltd.	STAMFORD.	L. R. KNAPP, Ltd.	CLANFIELD.
CHAS. BURRELL & SONS Ltd.	THETFORD.	E. R. & F. TURNER, Ltd.	IPSWICH.

A.G.E. ELECTRICAL CO., LTD., STOWMARKET.

The WEIR HYDROKINETER



Promotes boiler circulation; avoids unequal expansion of plates and consequent leakage

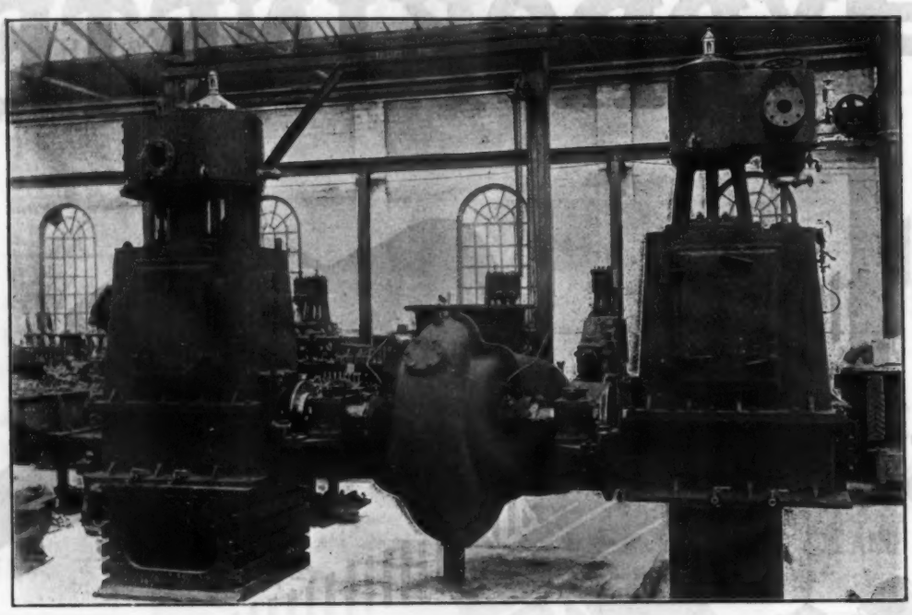
An inexpensive and effective apparatus with a thirty-five years' record of usefulness

G. & J. WEIR, Ltd. CATHCART GLASGOW

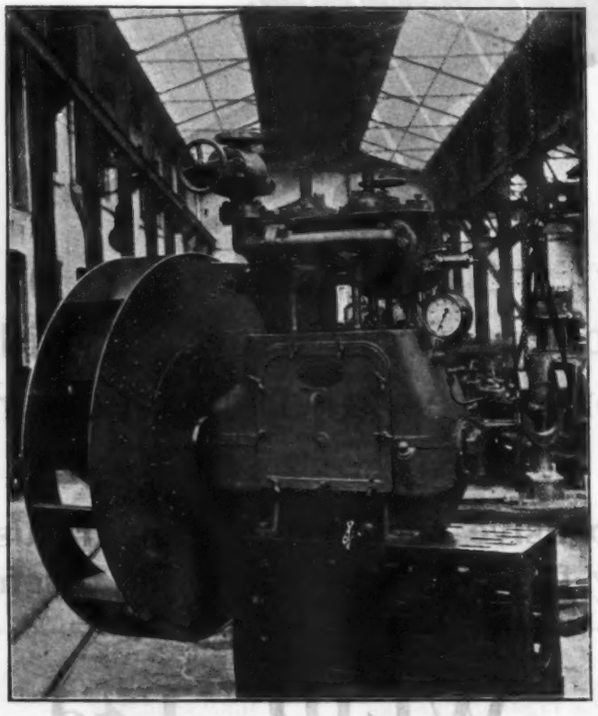
MATTHEW PAUL & CO., LTD.

LEVENFORD WORKS, DUMBARTON.

CENTRIFUGAL PUMPS AND ENGINES.



DYNAMO ENGINES. LAUNCH ENGINES.



8654

FANS AND ENGINES.

"Can you burn Refuse Fuel? My dear Sir— there is no 'refuse' fuel these days. ALL fuel is precious & can be turned into steam if you have

'BENNIS' STOKERS"

"Bennis" Machine Stokers afford a perfectly regular output of steam, even under the most trying conditions, and their flexibility permits a rapid response to urgent demands for increased steam.

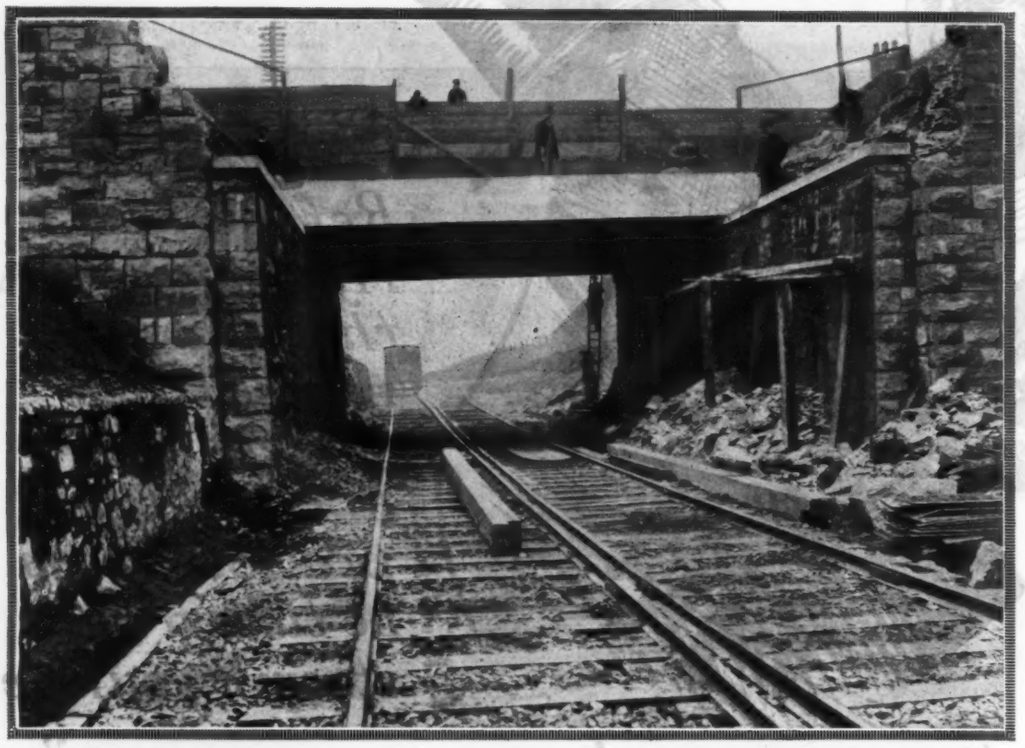
The principles of design in the "Bennis" standard types ensure smokelessness, an increased steam supply—from 10 to 50 per cent.—minimum labour costs, low fuel bills, an extended area of coal supply, nominal and negligible costs for repairs, in other words, CHEAP STEAM without smoke, under comfortable conditions.

Ed. Bennis & Co., Ltd.

LITTLE HULTON, BOLTON

***and* 28 Victoria Street, London, S.W.1**

CONCRETE REINFORCEMENT



Summerhill Bridge, Ireland, for Midland Great Western Railway Co. Reinforced entirely on B.R.C. System. Engineer: A. W. Bretland.
This bridge was built with pre-cast sections and the road traffic maintained during the whole time of construction.

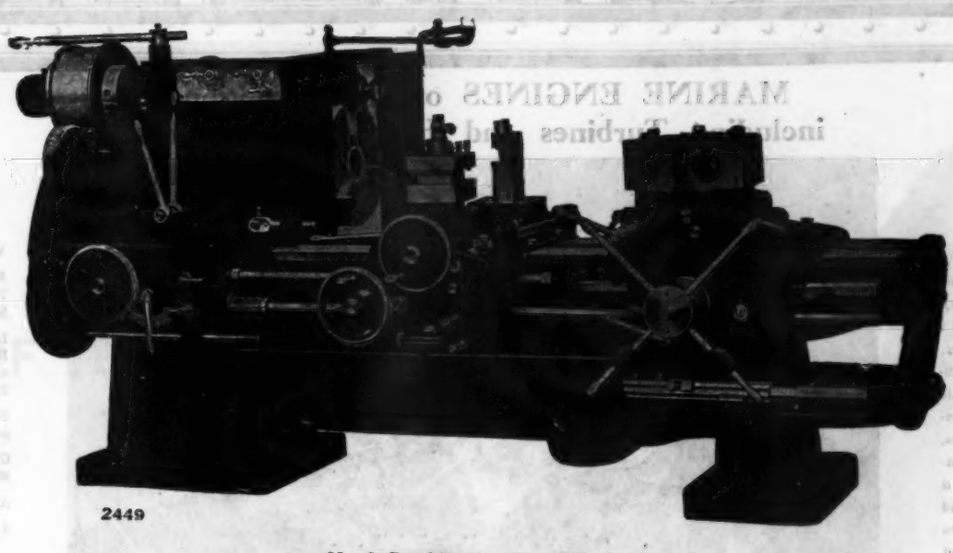
B. R. C. Reinforcements provide the greatest degree of security in all classes of reinforced concrete construction.

THE BRITISH REINFORCED CONCRETE ENGINEERING Co. LTD.
Head Office: 1, Dickinson Street, Manchester.
Works: Trafford Park, Manchester.
Branch Offices: LONDON, Iddesleigh House, Caxton St., Westminster, S.W. 1; LEEDS, 3, Park Lane; LIVERPOOL, 36, Dale St.; BRISTOL, 47, Whiteladies Road; GLASGOW, 62, Robertson St.; DUBLIN, 12, Ely Place; BELFAST, Mayfair Buildings, Arthur Square.

8303

B·R·C

ALFRED HERBERT LTD COVENTRY.



No. 9 Combination Turret Lathes.

TURRET LATHES FOR PROMPT DELIVERY.

Owing to increased manufacturing facilities which have been in operation for some considerable time we are now catching up with arrears and are able to offer several sizes of our well-known turret lathes for prompt delivery.

We have specialised in the application of turret lathes to the machining of repetition work of all kinds for upwards of 21 years and have naturally acquired a great deal of valuable experience.

We shall be pleased to quote for Machines fitted with the necessary tools and fixtures for dealing with specified work to guaranteed times.

Particulars of Machines we can at present offer for prompt delivery are as follows :—

DELIVERIES.

No. 4 Capstan Lathe, with single pulley head, 6½ in. centres, admits 2 in. diam. through plain head with 1⅝ in. through auto head - - - - - - - - - - - - 5 weeks.

No. 9 Combination Turret Lathe, with single pulley head, 10 in. centres, admits 3½ in. diam. through spindle - - - - - - - - - - - - - - - 1 week.

No. 9 Combination Turret Lathe, with cone pulley head, ditto - - - - - - - 1 week.

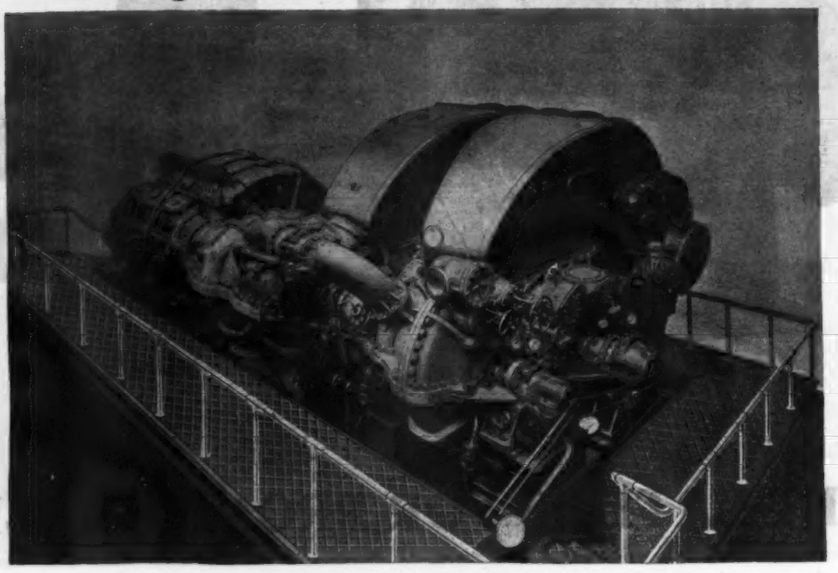
No. 17 Combination Turret Lathe, with cone pulley head, 11 in. centres, admits 5¾ in. diam. through spindle - - - - - - - - - - - - - - - 1 week.

LONDON: 64, Victoria Street, S.W. 1; Small Tool Dept., 25, Victoria Street, S.W. 1. GLASGOW: 36-38, West George Street. MANCHESTER: 30, Cross Street. NEWCASTLE: New Market Street. LEEDS: Atlas Chambers, King Street. SHEFFIELD: Queen Street Chambers, Queen Street. BIRMINGHAM: 208, Corporation Street. BRISTOL: 1, St. Stephen's Chambers, Baldwin Street. YOKOHAMA: 14, Yamashita-cho. OSAKA: 98, Sonesaki Kami. TOKIO: 13, Yamashita-cho, Kyobashiku. KOKURA: Osaka-Machi. NEW YORK: 54, Dey Street. AGENTS FOR FRANCE, SWITZERLAND, AND SPAIN: Société Anonyme Alfred Herbert, 47, Boulevard de Magenta, Paris; and 39, Cours de la Liberté, Lyons; 178, Rue Barthélemy-Delespaul, Lille; 270, Calle de Mallorca, Barcelona. AGENTS FOR ITALY: Societa Anonima Italiana Alfred Herbert, 42, Via Cajazzo, Milan. AGENTS FOR INDIA: Alfred Herbert (India) Ltd., 12, British Indian Street, Calcutta; Standard Buildings, Hornby Road, Bombay. AGENTS FOR BELGIUM: Société Anonyme Belge Alfred Herbert, 35a and 35b, Rue de Laeken, Brussels. AGENTS FOR SOUTH AMERICA: Percy Grant & Co., 25, De Mayo, Buenos Aires, Argentine. AGENTS FOR SOUTH AFRICA: South African General Electric Co., Southern Life Buildings, Johannesburg. AGENTS FOR HOLLAND: Landre & Glinderman, Amsterdam. AGENT FOR SWEDEN: Axel Bonthron, Stockholm, Sweden. AGENT FOR AUSTRALIA AND NEW ZEALAND: C. E. Young, 97, George Street North, Circular Quay, Sydney. Od 3300

VICKERS

MARINE ENGINES of all descriptions, including Turbines and Heavy Oil Engines.

High Efficiency Vacuum Plants, Contraflo Condensers, Kinetic Reciprocating Air Pumps, Cascade Filters, Winch Condensers, Feed Heaters and Evaporators for Land and Marine Installations.



Warships.

Mail and Passenger Steamers.

Icebreakers, Dredgers, and other Special Craft.

Floating Docks and Cranes.

Guns and their Mountings.

Aircraft.

Armour Plates.

Large Gas Engines.

Geared Turbines as above, from 20,000 to 45,000 H.P. Constructed at Barrow-in-Furness.

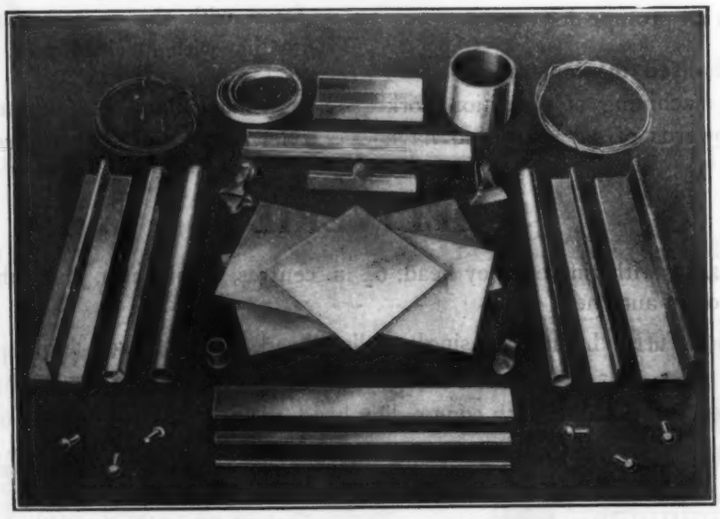
LIGHT AS ALUMINIUM.
Specific Gravity 2·8.

"DURALUMIN"
(REG. TRADE MARK.)

STRONG AS STEEL.
Tensile Strength up to 35 tons.

An alloy of Aluminium with the strength and hardness of Mild Steel, but having only one-third of its weight. Will not rust. Almost unaffected by sea water.

It is an ideal substitute for Aluminium, Nickel, Silver, Brass, Copper, Nickel-Plated and Silvered articles, and it is the only substitute for Steel where Lightness combined with the strength of that metal is required.



For Scientific Apparatus, Instruments of Precision, Orthopædic Apparatus and Hospital Supplies, &c.

For Aeroplanes, Dirigibles, Hydroplanes, Motor Car, Yacht and Boat Fittings, &c.

VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.

VICKERS LIMITED,
VICKERS HOUSE, BROADWAY, LONDON, S.W. 1.
Works: BARROW-IN-FURNESS, SHEFFIELD, BIRMINGHAM, CRAYFORD, DARTFORD, ERITH, IPSWICH, WEYBRIDGE.

VICKERS

FILES

OF EVERY DESCRIPTION.

REGISTERED TRADE MARK.

River Don Works,
SHEFFIELD.

SPECIAL STEEL FORGINGS

OF ALL DESCRIPTIONS.

Aero Engine Crankshaft.

RAILWAY MATERIAL, Steel Tubes and Sheets, Magnets, Bevel Gears, Gauge Plates, **VICKERS SPECIAL STEELS.**

River Don Works, **SHEFFIELD.**

REGISTERED TRADE MARK.

VICKERS LIMITED,

VICKERS HOUSE, BROADWAY, LONDON, S.W. I.

WORKS: BARROW-IN-FURNESS, SHEFFIELD, BIRMINGHAM, CRAYFORD, DARTFORD, ERITH, IPSWICH, WEYBRIDGE.

FOSTER FIXED FOCUS FOR FIERY FURNACES!

The ideal pyrometer for high temperatures.

INSTRUMENTS IN STOCK.

New descriptive Catalogue E 23, post free.

FOSTER INSTRUMENT CO., Letchworth, Herts, ENGLAND

Joseph Booth & Bros. Limited, RODLEY, LEEDS.

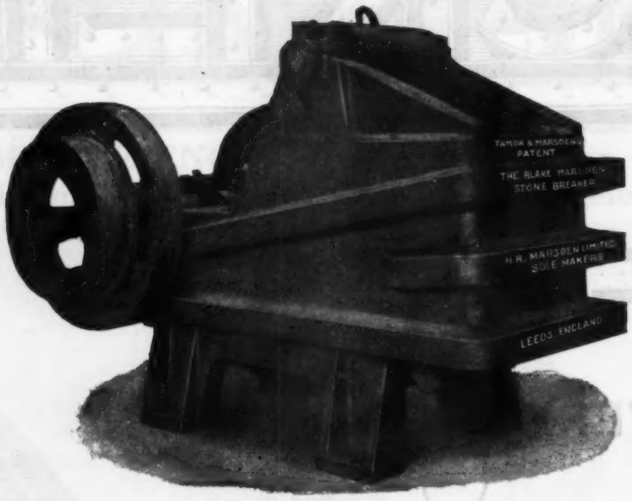
ALL TYPES & ALL SIZES.

8439

See our Advt. in alternate issues.

CRANES

STONE BREAKERS, ORE CRUSHERS, SCREENING AND ELEVATING PLANTS.



BLAKE-MARSDEN PATENT "X" TYPE STONE BREAKER.

H.R. MARSDEN, LIMITED, SOHO FOUNDRY, LEEDS.

London Offices:

17, ST. SWITHIN'S LANE, E.C. 4.

8062

"The Theory and Practice of PLATE CLUTCHES."

By the Inventors of

FERODO FRICTION LININGS

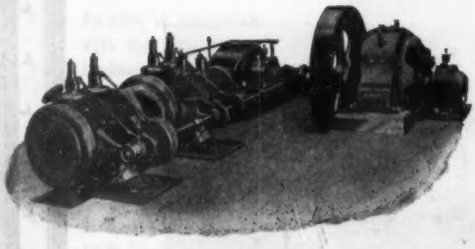
8002

WE have lately produced a brochure on the attractive proposition of power transmission by plate clutches.
It publishes for the first time information of special interest to engineers in this the transition period.
It will be sent post free on receipt of a request.

FERODO LTD. CHAPEL-EN-LE-FRITH.

Contractors to the War Office and Admiralty, London General Omnibus Company, and Underground Electric Railways of London and Paris.

Depôts at London, Birmingham, Bristol, Cardiff, Coventry, Edinburgh, Glasgow, Liverpool, Manchester, Newcastle & Swansea.



Paxman

Positive Valve Gear Engines are suitable for boiler pressures up to 200 lbs. per square inch, with a total steam temperature up to 600 degrees Fahr. The economy of the steam consumption of these engines is remarkable, it being possible to obtain one-horse power for every 9½ to 10½ lbs. of superheated steam.

Write for Catalogue No. 723.

O 5901

DAVEY, PAXMAN & Co., Ltd., COLCHESTER, and 78, Queen Victoria Street, E.C.

Manufacturers of all kinds of Steel from the hardest to the softest grades.

TRADE HECLA MARK

STEEL FORGINGS

in the rough, rough machined, or finished for Marine and other Engineering purposes, of any analysis and to pass any required test.

Ingots, Blooms, Slabs

by the

OPEN HEARTH OR ELECTRIC PROCESS

8681

STEEL CASTINGS OF EVERY DESCRIPTION

up to 30 tons in weight.

Special Alloy High Tensile Steel for Aircraft and Motor Car Parts.

Makers of the best kinds of

STONE BREAKING & ORE CRUSHING MACHINERY,

including Gyratory, Jaw and Disc Crushers.

Sole Makers of Hadfield's Patent

ERA (TRADE MARK.)

MANGANESE STEEL

THE SUPREME MATERIAL

for Railway and Tramway Special Track-work, also Wearing parts of Stone-breaking and Ore Crushing Machinery, etc.

HADFIELDS LTD.

Workmen employed during the War: 15,000.

East Hecla and Hecla Works, SHEFFIELD, ENGLAND.

Works area: over 200 acres.

Model 56. 18 by 8 inches.

WE claim long-way-ahead
SUPERIORITY
for our fine line of
UNIVERSAL, PLAIN & INTERNAL Grinding Machines

and invite every manufacturer interested in accurate finishing work, done on a modern high-production basis, to pay a visit to our "New Century" Works at Leicester.

Jones & Shipman LIMITED LEICESTER

Model 539. 24 by 8 inches.

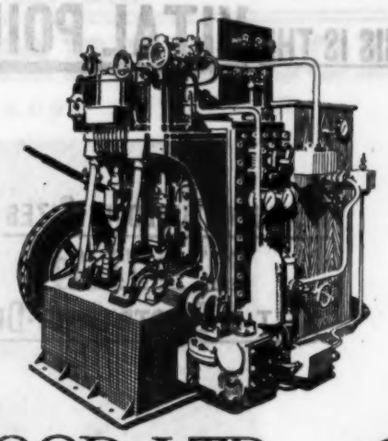
AMMONIA and CO_2

REFRIGERATING MACHINERY

of improved and patented designs. Complete refrigerating and ice making installations.

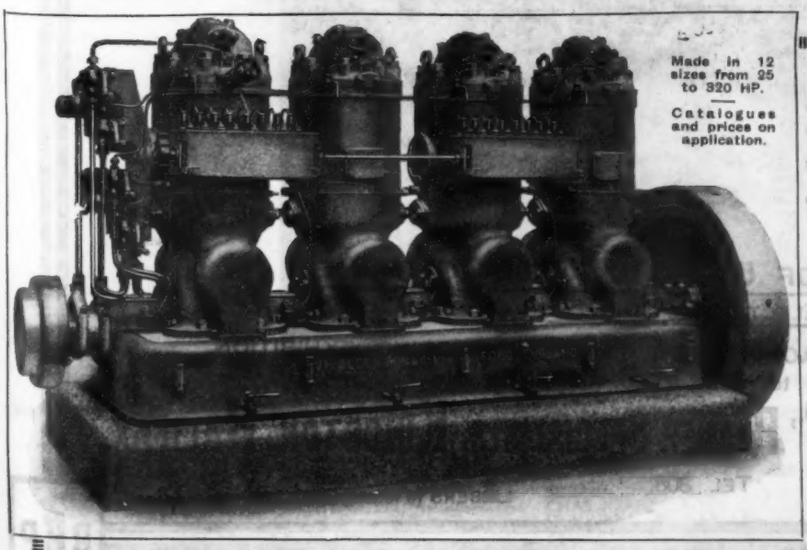
Illustrated catalogue of refrigerating plant details will be sent on request.

Brotherhood Standard productions include Steam Engines and Turbines; Petrol, Gas and Oil Engines; Air and Gas Compressors; Fans, etc.,
for which enquiries are invited.



PETER BROTHERHOOD LTD
Head Office & Works
PETERBOROUGH · ENGLAND
BRANCHES:— LONDON · MANCHESTER · NEWCASTLE-ON-TYNE
BIRMINGHAM AND GLASGOW.

FOUNDED 1867



Made in 12 sizes from 25 to 320 HP.

Catalogues and prices on application.

THE "ALLEN" Heavy Fuel Oil Engine

THE "ALLEN" Heavy Fuel 2-stroke Oil Engine is simple in construction and simple to operate. For an internal Combustion Engine it has a minimum number of working parts, rendering it especially suitable for use where skilled engineers are unobtainable.

Runs equally well with Crude Oil, Refined Petroleum, Shale, or low grade and cheap oils.

Special Features—

- Great Flexibility.
- Low Fuel Consumption.
- Small Space Required.
- Length of Life.
- Forced Lubrication to Moving Parts.
- Perfect Combustion.
- Quick Starting.
- Simplicity in Use.
- Freedom from Deposit in Cylinder.
- Accessibility to Working Parts.
- No Compressed Air used for Fuel Injection.

7812

W. H. ALLEN, SONS & CO., LTD.,
Queens Engineering Works, ∴ ∴ BEDFORD, England.

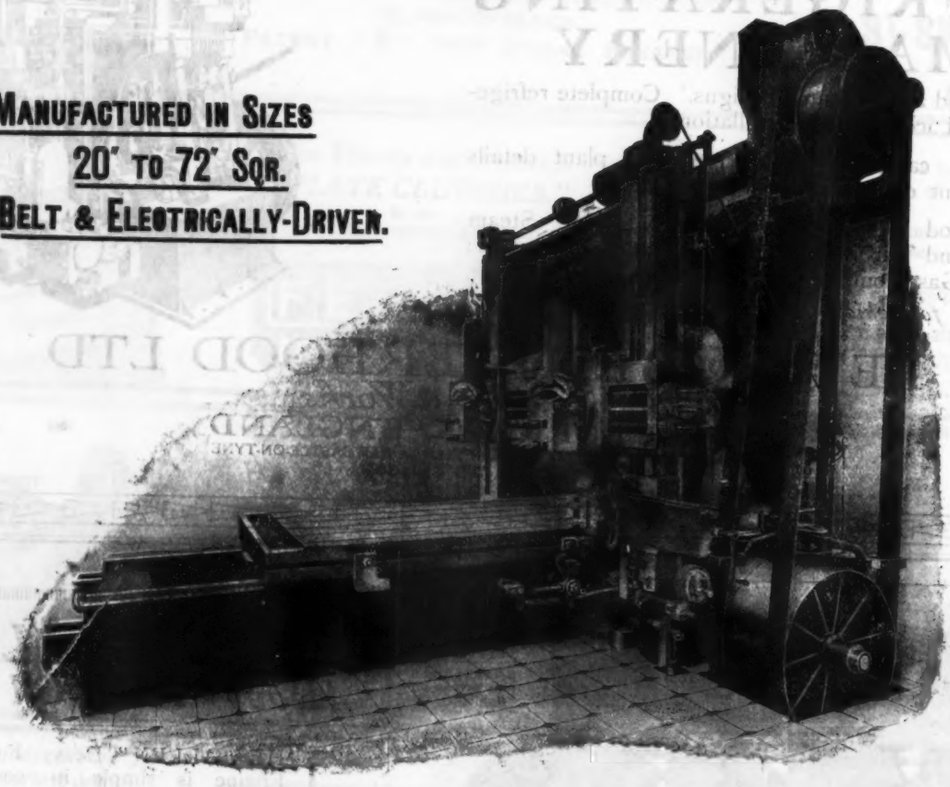
RRP RRP

WHY A "REDMAN"?

BECAUSE IT IS A CAPITAL INVESTMENT FOR REDUCING YOUR LABOUR COSTS

THIS IS THE VITAL POINT THAT STRIKES ALL WHO USE THEM

MANUFACTURED IN SIZES
20" TO 72" SQR.
BELT & ELECTRICALLY-DRIVEN.



9063

ILLUSTRATION OF 5' × 5' × 10' SELF-CONTAINED.
ELECTRICALLY-DRIVEN.

We are Exhibiting at the MACHINE TOOL AND ENGINEERING EXHIBITION, ——held on September 4th to 25th, 1920. STANDS No. 80 and 81.——

C. REDMAN & SONS, LTD., PLANER SPECIALISTS, KINGSTON, HALIFAX.

Telegrams and Cables: "PLANERS, HALIFAX." TEL. 308. Codes: LIEBERS (5 letter), and A B C (5th Edition).

RRP RRP

TILGHMAN'S SAND BLAST APPARATUS

(Arranged for the Operator to work either inside or outside the Sand Blast Chamber).

FOR CLEANING LARGE AND SMALL CASTINGS.

WILL SAVE 50 PER CENT. IN FETTLERS' WAGES.

IN USE BY THE FOLLOWING WELL-KNOWN FIRMS:

STEEL CASTINGS.		ORDINARY IRON CASTINGS.		MALLEABLE IRON.		BRASS OR GUNMETAL.	
Beardmore, W., & Co., Ltd.	Glasgow	Platt Bros. & Co., Ltd	Oldham	Leys Malleable Castings Co., Ltd.	Derby	Vickers Limited	Barrow
Steel Co. of Scotland	Glasgow	Tweedales & Smalley	Castleton	Crowley, John, & Co., Ltd.	Sheffield	Gummer & Co.	Rotherham
Coltness Iron Co.	Coltness	H.M. Dockyards	—	Baker Foundry Co., Ltd.	Smethwick	Ruston & Hornsby, Ltd.	Lincoln
Dickson & Manns, Ltd.	Armadale	Dobson & Barlow, Ltd.	Bolton	Maddocks, J., & Co., Ltd.	Oakengates	Storey, Isaac, & Sons, Ltd.	Manchester
Vickers Limited	Barrow	Doulton & Co., Ltd.	Paisley	Clegg & Howgate, Ltd.	Keighley	Glenfield & Kennedy	Kilmarnock
Darlington Forge Co., Ltd.	Darlington	Ruston & Hornsby, Ltd.	Lincoln	Croft Foundry Co., Ltd.	Walsall	Milne, J., & Son	Edinburgh
Shaw, W., & Co.	Middlesbrough	Marshall, Sons, & Co., Ltd.	Gainsborough	Lindop, H. W.	Walsall	Benton & Stone	Birmingham
Haddfelds' Steel Foundry Co., Ltd.	Sheffield	Shanks & Co., Ltd.	Barrhead	Tangyes Ltd.	Birmingham	British Insulated & Helsby Cables, Ltd.	—
Osborn, S., & Co., Ltd.	Sheffield	Falkirk Iron Co.	Falkirk	Harper, J., & Co.	Willenhall	Marshall, Sons, & Co., Ltd	Gainsborough
Jackson, P. R., & Co., Ltd.	Manchester	Hopkinson & Co.	Huddersfield	Haden, G. N., & Sons	Trowbridge	Dewrance & Co.	London
Atlas Steel Foundry & Eng. Co., Ltd.	Armadale	A. Kenrick & Sons, Ltd.	West Bromwich	Brampton Bros.	Birmingham	Barr & Strouds Patents	Glasgow
John Spencer & Sons, Ltd.	Newcastle-on-Tyne	Cannon Iron Foundries	Wolverhampton	Clive, Thos., & Son	Birmingham	Hopkinson & Co., Ltd.	Huddersfield
Cammell Laird & Co., Ltd.	Sheffield	Holcroft, Thos., & Sons, Ltd.	Wolverhampton	Gameson, T., & Sons, Ltd.	Walsall	Harlow & Son	Stockport
Brown, John, & Co., Ltd.	Sheffield	Geo. Salter & Co.	West Bromwich	Hackett & Sons	West Bromwich	Woodhouse & Co.	Doncaster
Allen, R., & Co., Ltd.	Sheffield	Clark, T. and C., & Co.	Wolverhampton	Hill, H. and J.	Willenhall	Hill, C. and L.	Willenhall
Electro Flex. Steel Co., Ltd.	Newcastle-on-Tyne	Swain, Matthew, Ltd.	Manchester	Parkes, G. B., Ltd.	Halesowen	Showell, B., & Sons, Ltd.	Birmingham

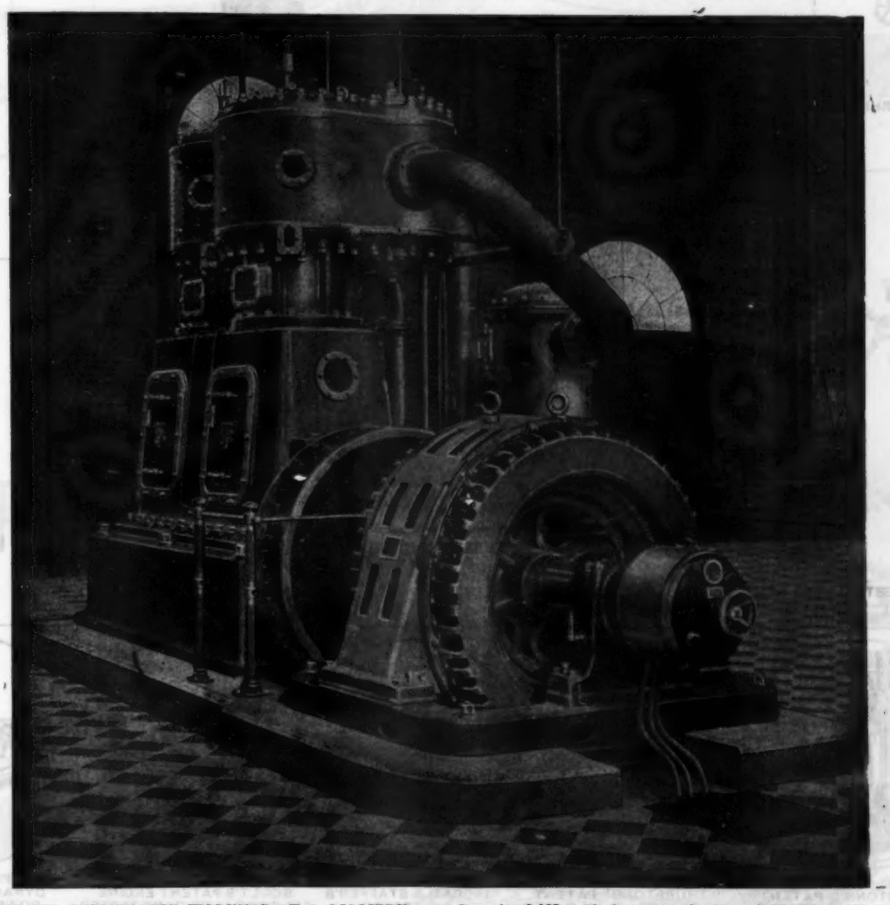
Representative; GEO. HOPKINS, 10, Sanctuary House, Broadway, Westminster, S.W.

TILGHMAN'S PATENT SAND BLAST CO.,

BROADHEATH, NEAR MANCHESTER. **Limited,**

TILGHMAN'S AIR COMPRESSORS.

FOR ALL PURPOSES. ***OVER 4,000 SUPPLIED.***



STANDARD TYPE AIR COMPRESSOR WORKING AT A COLLIERY. **Capacity 2,000 cubic feet per minute.** **Pressure 100 lbs., 295 R.P.M.**

Standard Vertical and Horizontal Enclosed Types 50 to 5,000 cubic feet per minute. The outstanding features of these machines are SIMPLICITY, RELIABILITY, ACCESSIBILITY and EFFICIENCY combined with silent working at high speed.

Amongst the users of these Compressors are the following well-known firms:—

741

SIR RAYLTON DIXON & Co., Ltd., Middlesbrough.
SIR W. G. ARMSTRONG, WHITWORTH & Co., Ltd., Newcastle-on-Tyne.
GREAT WESTERN COLLIERY Co., Ltd., Pontypridd.
CLIFTON & KEARSLEY COAL Co., Ltd., Manchester.
VULCAN FOUNDRY Ltd., Newton-le-Willows.
MIDLAND COAL, COKE & IRON Co., Ltd., Newcastle.
SKINNINGROVE IRON Co., Ltd., Saltburn-by-the-Sea.
CHAS. RENNOLDSON & Co., South Shields.
OSBOURNE, GRAHAM & Co., Ltd., Sunderland.
TYNE IRON SHIPBUILDING Co., Ltd., Willington-on-Tyne.
BABCOCK & WILCOX, Renfrew.
BLYTH SHIPBUILDING & DRY DOCKS Co., Ltd., Blyth.
H.M. DOCKYARD, Haulbowline.
MANCHESTER DRY DOCKS Co., Ltd., Manchester.
MERCANTILE DRY DOCKS Co., Ltd., Jarrow-on-Tyne.
COOK, WELTON & GEMMELL, Ltd., Beverley.
JOHN READHEAD & SONS, Ltd., South Shields.
ARDROSSAN DRY DOCK & SHIPBUILDING Co., Ltd.

TILGHMAN'S PATENT SAND BLAST CO., LTD., Broadheath, near Manchester.

BAILEY'S TESTERS

Are used by the BRITISH and most FOREIGN GOVERNMENTS, the leading UNIVERSITIES, TECHNICAL SCHOOLS, RAILWAYS, CONTRACTORS, IRON and STEEL WORKS, &c.

Fig. 5100.—HYDRAULIC IRON AND STEEL TESTER.
To 10, 25, and 50 Tons.

BAILEY & REID'S PATENT CEMENT TESTER.
To 1000 & 2000 lbs.

Fig. 5111.—SANITARY PIPE CRUSHING TESTER.

Fig. 5023.—SANITARY PIPE HYDRAULIC TEST PRESS.

STER-HYDRAULIC TEST PRESS.
For crushing tests, and for extracting oils, &c.

STER-HYDRAULIC CRUSHING TESTER.

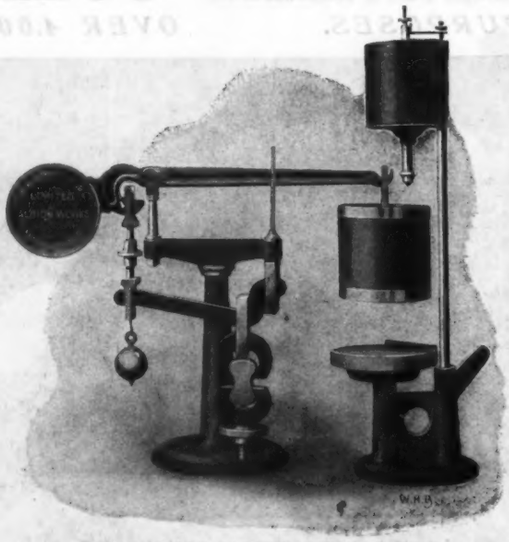


Fig. 5062.—TABLE PATTERN CEMENT TESTER.
With new design Shot Filler. To 1000 lbs.
To BRITISH STANDARDS

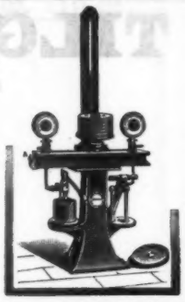


Fig. 5040.—BAILEY'S PATENT PRESSURE and VACUUM GAUGE TESTER.

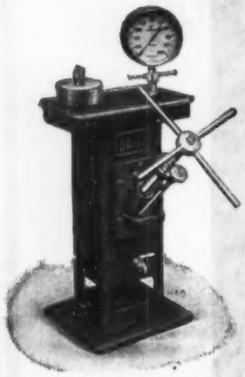


Fig. 5171.—BAILEY'S NEW PATTERN DEADWEIGHT GAUGE TESTER.
For Pressures to 800 lb.

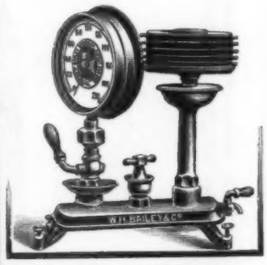


Fig. 5041.—DEADWEIGHT PRESSURE GAUGE TESTER.
To 200 and 300 lb.

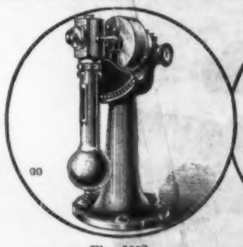


Fig. 5003.—"THURSTONS" PATENT PATTERN OIL TESTER
For Railways & Steamship Co.s', Iron & Steel Works, Collieries Chemical Works, &c.

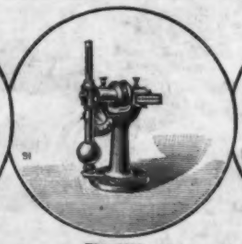


Fig. 5002.—"THURSTONS" PATENT OIL TESTER. Table Pattern.

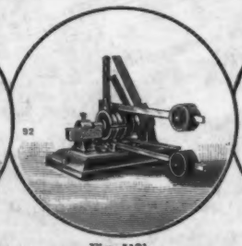


Fig. 5131.—INGRAM & STAFFER'S OIL TESTER.

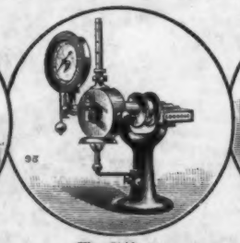


Fig. 5109.—BOULT'S PATENT ENGINE CYLINDER LUBRICANT TESTER.

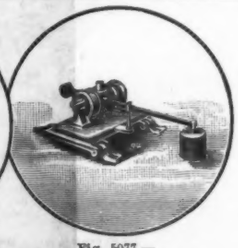


Fig. 5077.—DYNAMOMETER or POWER TESTER.

Manufactured by

SIR W. H. BAILEY & CO., LTD.,

At the ALBION WORKS, SALFORD, MANCHESTER.

7741

Save Time

—*and* Capital—*and* Labour—*and* Repairs

by installing our intercommunicating phone. You are then *directly in touch* with every department—however extensive your premises are. You can talk *instanter* with any of your Managers or Foremen. Invaluable in Shipyards, Foundries, Offices, etc.

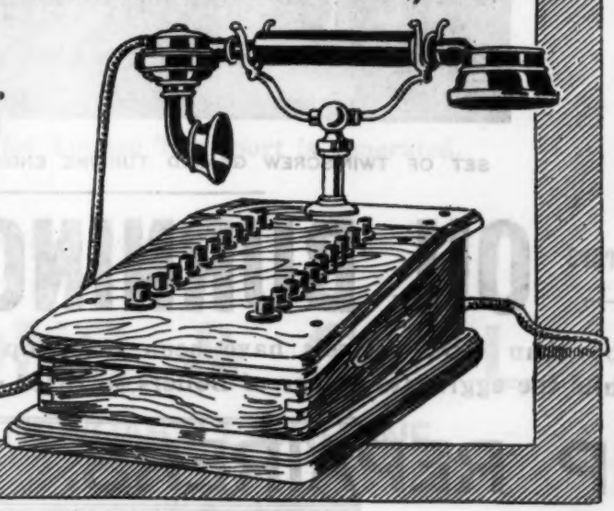
8391

Particulars from

THE TELEPHONE MANUFACTURING Co., Ld.

WEST DULWICH,
LONDON, S.E.21

Telephone: *Sydenham 1067*
Telegrams: *Bubastis—Dulcrox*



The Illustration shows a desk instrument for 20 lines, with microphone and automatic communication

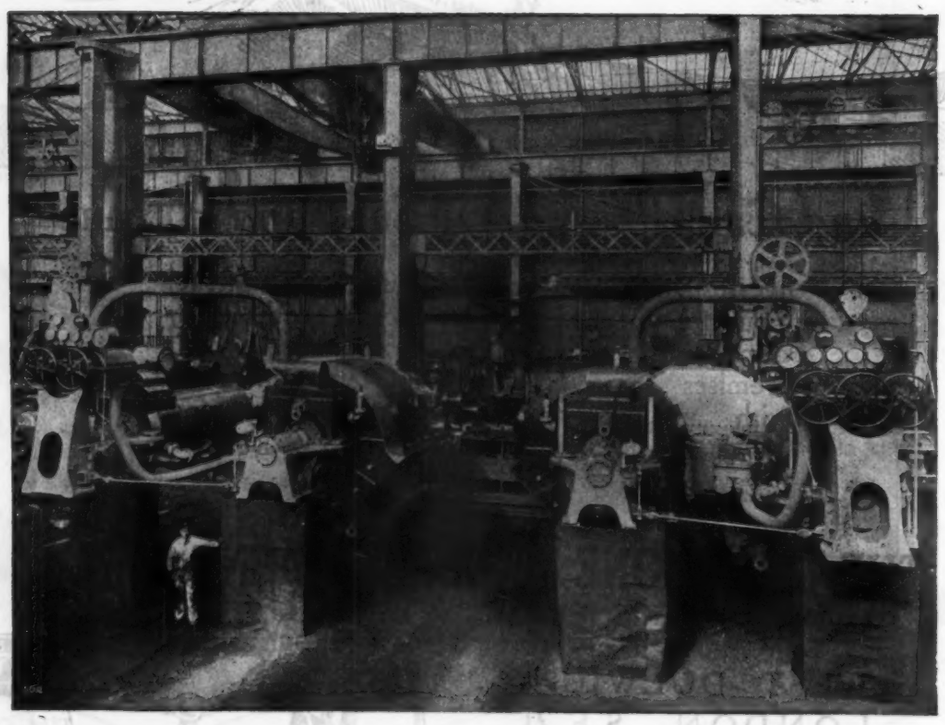
THE WALLSEND SLIPWAY AND ENGINEERING CO., LTD.

WALLSEND-ON-TYNE

Builders of ALL TYPES of

Machinery for Warships

High-Speed Liners and Merchant Vessels.



SET OF TWIN-SCREW GEARED TURBINE ENGINES FOR LARGE MERCHANT VESSEL.

Manufacturers — of — **OIL BURNING INSTALLATIONS**

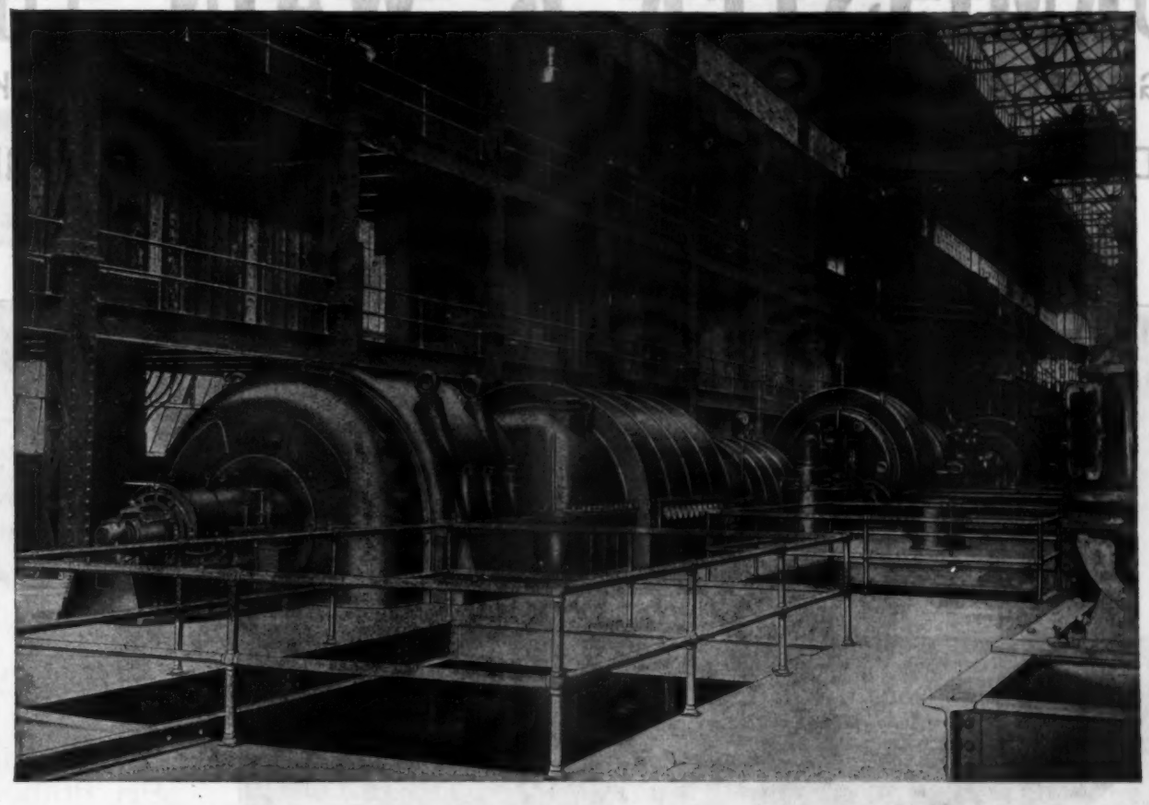
More than 450 Vessels have been fitted up by the Company for burning oil fuel; while the aggregate power of Boilers so fitted exceeds 4,500,000 HORSE POWER. 8260

SHIP REPAIRERS. Graving Dock 540 ft. long.

Works and Offices - - - - WALLSEND-ON-TYNE.

Telegrams—"WALL, NEWCASTLE-ON-TYNE."

LONDON Office - - 30, GREAT ST. HELENS, E.C.



Parsons Turbo Alternators

for

Efficiency and Reliability.

The illustration is of the 15,000-18,000 Kw. three-phase Turbo Alternator at Lots Road, London, where a large proportion of the Electrical energy required for London Transport is generated.

Our experience is at your service.

C. A. PARSONS & Co., LTD.

HEATON WORKS, NEWCASTLE-ON-TYNE.

London Office: 8, Victoria Street, S.W. 1.

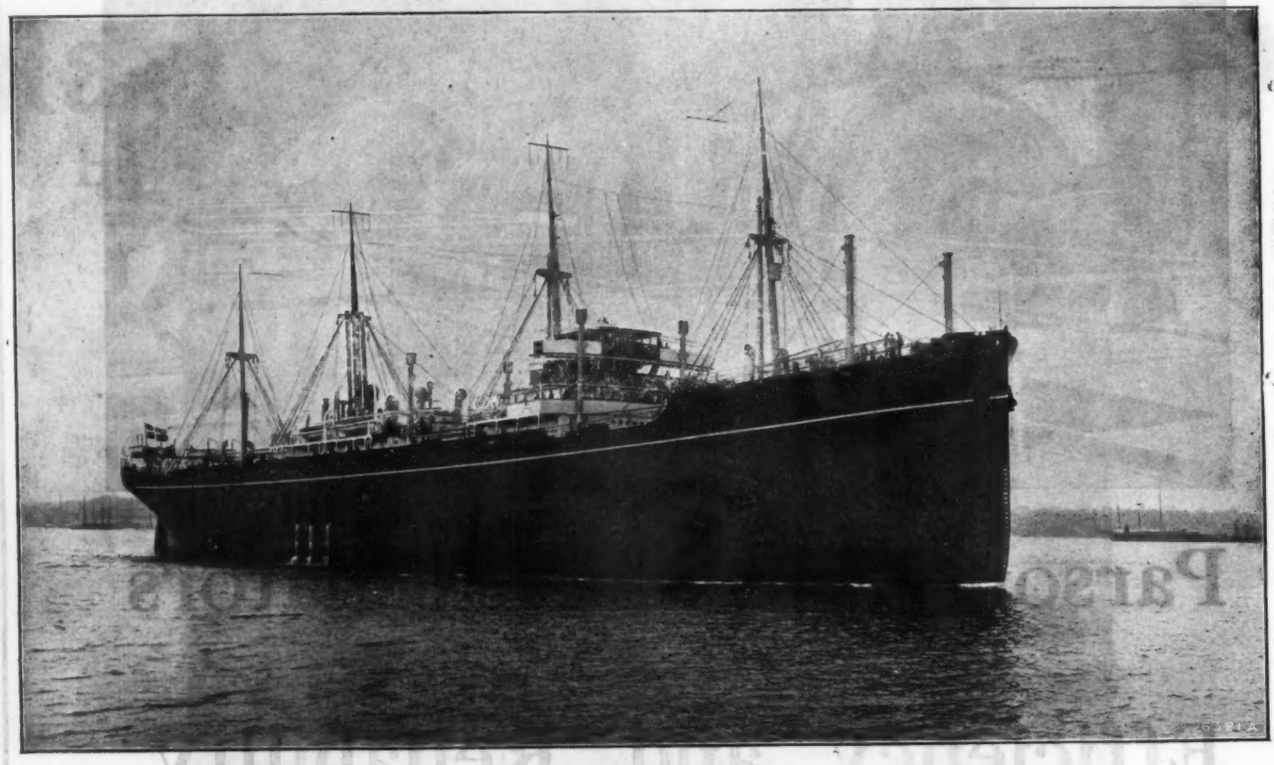
8169

BURMEISTER & WAIN, LTD.,

ENGINEERS AND SHIPBUILDERS, COPENHAGEN, DENMARK.

BUILDERS OF LARGE SEAGOING DIESEL MOTOR SHIPS

CARGO VESSELS AND LINERS UP TO 600 FT.



T.M.S. "AFRICA" THE LARGEST MOTOR SHIP AFLOAT. 13,300 TONS D.W. AT FULL LOAD. 12 KNOTS SPEED ON 15 TONS OIL FUEL PER DAY.

THE FOLLOWING IS A LIST OF SEAGOING **DIESEL MOTOR VESSELS** DESIGNED, BUILT, AND ENGINED BY US:

NAME.	D.W. Tons.	Knots.	I. HP.
SELANDIA	7400	11	2500
CHRISTIAN X	7400	11	2500
SUECIA	6500	11	2000
PEDRO CHRISTOPHERSEN	6500	11	2000
SIAM	9275	11½	3000
ANNAM	9275	11½	3000
KRPRS. GUSTAF ADOLF	6500	11	2000
KRPRSE. MARGARETA	6500	11	2000
CALIFORNIA	8270	11	2700
FIONIA	6800	13	4000
MALAKKA	9000	11½	3100
TONGKING	9000	11½	3100
PACIFIC	6500	11	2000

NAME.	D.W. Tons.	Knots.	I. HP.
SAN FRANCISCO	6500	11	2000
PANAMA	9000	11½	3100
AUSTRALIEN	9000	11½	3100
COLUMBIA	9500	11½	3100
CHILE	9500	11½	3100
OREGON	8750	11	2600
PERU	9500	11½	3100
GEORGE WASHINGTON	9400	11½	3100
BONHEUR	10800	11½	3100
ASIA	10800	11½	3100
VALPARAISO	6500	11½	2600
LIMA	6500	11½	2600
AFRIKA	13000	12	4500

8183

Besides above-mentioned Vessels 18 Diesel Motor Vessels have been built by Firms in other Countries, holding License for Building

OUR 4 STROKE DIESEL ENGINES.

TOTAL: 44 SHIPS AGGREGATING 355,000 TONS D.W. AND 122,100 I.H.P.

SCHNEIDER & CIE

HEAD OFFICE - - - 42, RUE D'ANJOU, PARIS (8E)

LONDON OFFICE:—30, VICTORIA STREET, S.W. 1. Telephone:—Victoria 9844, 9845, 9846.

10,000 Kws. Turbo Alternators

GENERAL EQUIPMENT FOR POWER STATIONS

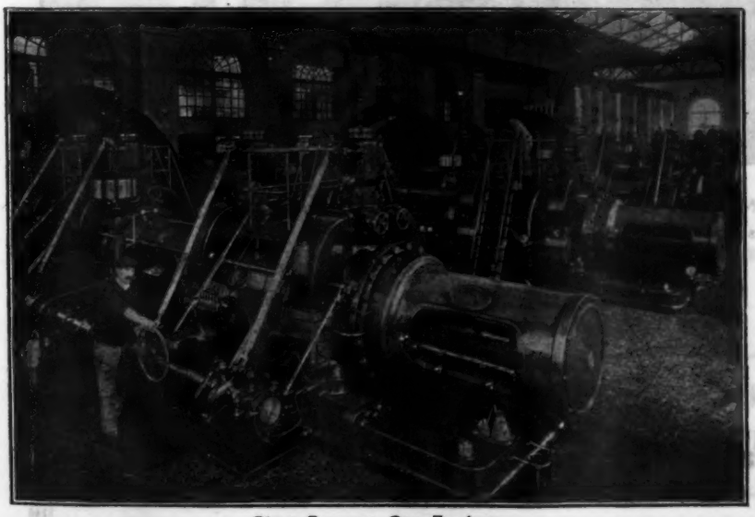
GAS ENGINES UP TO 3000 HP.

BLOWING ENGINES

STEAM AND ELECTRIC WINDING PLANT

ROLLING MILLS

3000 HP. Blowing Engine



Blast Furnace Gas Engines

STEEL CASTINGS AND FORGINGS OF EVERY DESCRIPTION

SPARE PARTS FOR ABOVE MACHINERY

8040

Tubi-Togni, Ltd., Brescia.

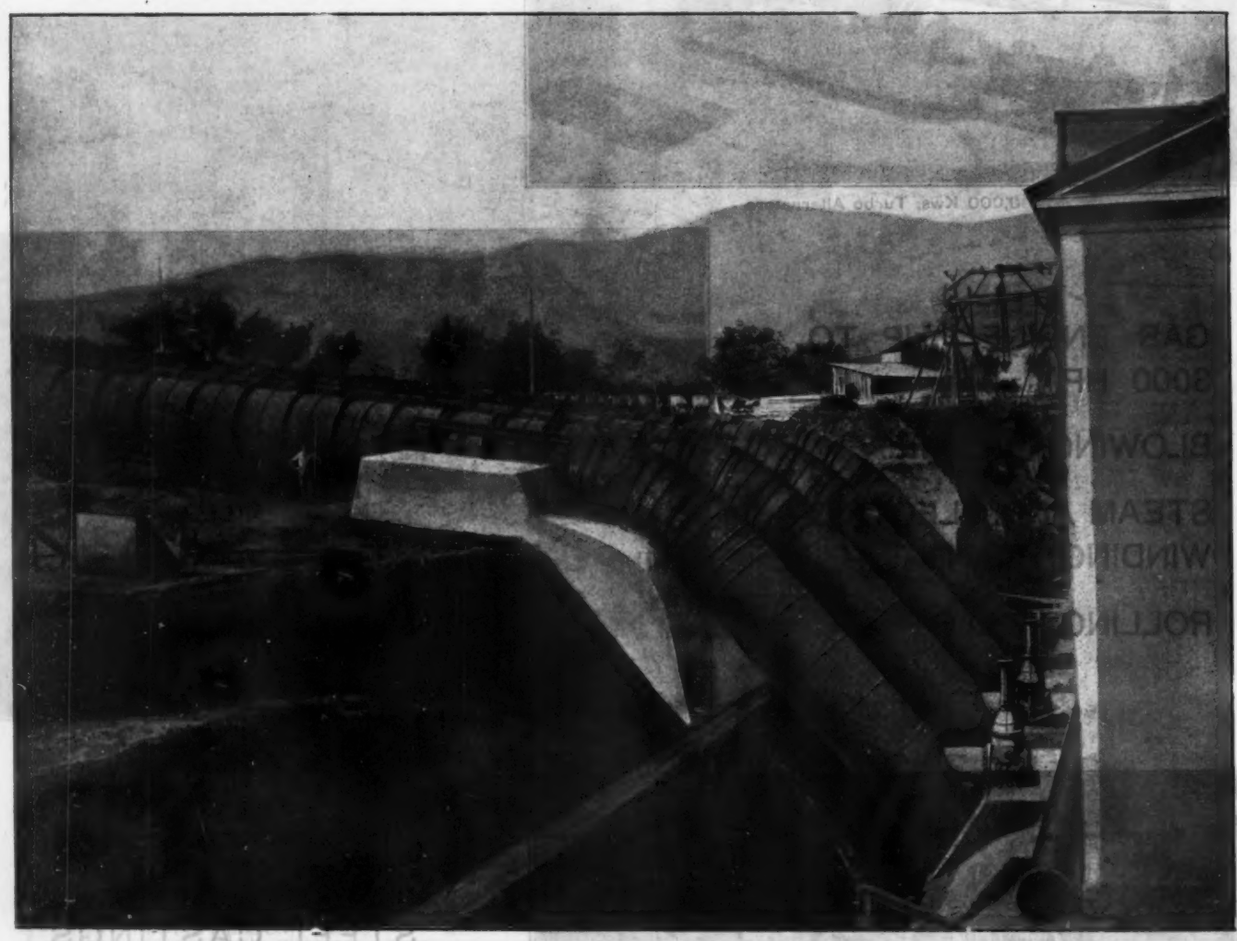
WORKS IN BRESCIA AND COGOLETO (ITALY).

Pipes and Tubes

Of Iron and Steel Plates, Welded or Riveted, of all sizes and for every pressure.

---

500 Plants performed with a total power of 1,200,000 HP. and the highest waterfalls in the world.



SOCIETA ELETTROCHIMICA ITALIANA, ROMA. HYDRO-ELECTRIC PLANT AT PESCARA.
Diameter of Supply Pipes: 2100/2300 mm. Power developed: 30,000 HP.

Metallic Dams. Grates. Safety Apparatus. Valves.

Secundary Parts for Water Pipings.

8146

STEEL PLATES

BULLET PROOF PLATES

capable of stopping high velocity ammunition.

SPECIAL ANALYSIS PLATES

heat treated, for secondary armouring of Battle Ships, Cruisers, &c.

5-PLY SAFE and VAULT STEEL

a composite plate of hard and soft layers. Burglar-proof and fire-proof.

LOCOMOTIVE FIRE BOX and BOILER PLATES

Our experience in the manufacture of special plates for railroad locomotives extends over 35 years, during which time we have supplied practically all of the principal railroads in the United States.

SHIP PLATES
TO LLOYD'S SPECIFICATIONS

MARINE STEEL PLATES

TOOL STEEL PLATES

SAW PLATES

CARBON STEEL COMPANY

General Offices and Works:

PITTSBURGH, PENNA., U.S.A.

Cable Address: CARBON, PITTSBURGH, U.S.A.

8417

The WORLD DEMANDS WORLD SERVICE

Producers and Consumers both great and small, in the United States, in Europe, in Asia, in South America, in Africa, are today doing business with each other on a world scale.

To do so effectively and profitably there is needed that coordination, that central source of contact, which the highly organized expert and specialized export and import company provides. The success we have achieved and the world service we are able to render to our clients is based upon a complete and far reaching organization that has understood the fundamentals and mastered the details of international trade.

Blooms, Billets and Slabs, Angles, Beams and Channels, Plates, Universal and Sheared, Bar Iron, Bar Steel, Wire Rods and Wire Products, Sheet Steel Products, Tool Steel, Tin Plate, Pipes and Tubes, Bolts, Nuts, Rivets, Washers, Shipbuilding Material, Axles, Rails, Portable Tracks, Car Wheels, Track Bolts, Railroad Spikes and Supplies, Ores, Pig Iron, Ferro-Alloys, Coal, Coke and Metals, Machinery, Industrial Equipment, Structural Material.

AMERICAN STEEL EXPORT COMPANY
Woolworth Building New York, U.S.A.
Cable Address: "ALLPORTS"

8090

"IRONITE"

ENTIRELY BRITISH

Registered Trade Mark.

BRAND CEMENT for FLOORING

MAKES CONCRETE FLOORS WEAR PROOF, DUST PROOF, WATER PROOF, GREASE PROOF.

CONTRACTORS TO WAR OFFICE, ADMIRALTY, AND OTHER GOVERNMENT DEPARTMENTS.

LARGE GOVERNMENT RESERVOIR RENDERED TIGHT WITH IRONITE.

Also "IRONITE" BRAND CEMENT for WATERPROOFING.

For rendering, *at a very low cost,* Cement, Bricks, Concrete, Wood, &c., *absolutely Waterproof and Oil Proof* against heavy pressure

FLAT ROOFS rendered Waterproof at less than half the cost of Asphalt.

For full particulars apply to—

The IRONITE COMPANY, Limited

(Managers—S. THORNELY MOTT & VINES, Ltd.),

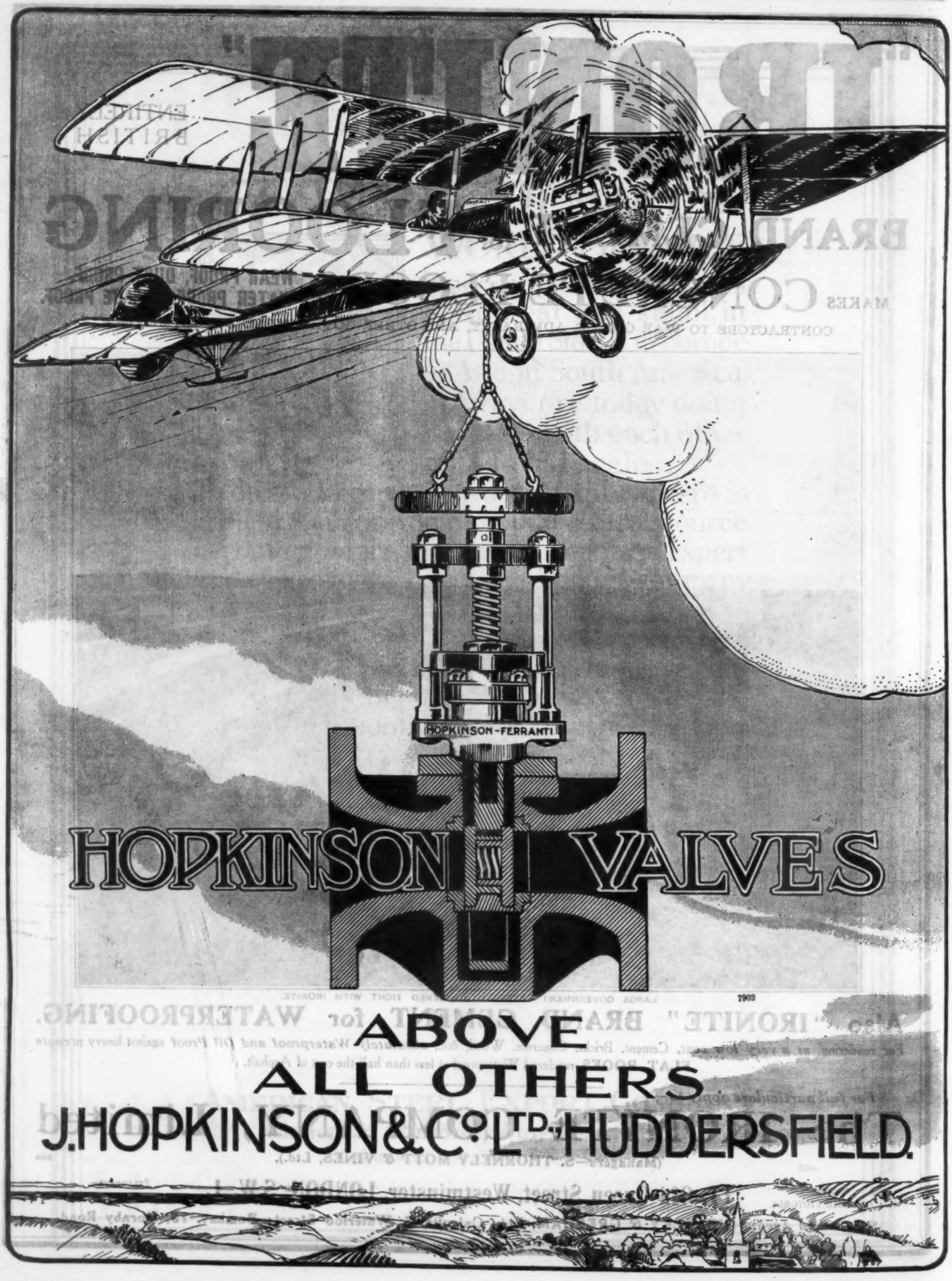
8504

TELEPHONE— No. 5618 VICTORIA.

11, Old Queen Street, Westminster, LONDON, S.W. 1.

TELEGRAMS— THORMOTVIN, VIC., LONDON.

Sole Indian Agents—HEATLEY & GRESHAM, Ltd., Calcutta, 6, Waterloo Street; Bombay, 75, Horaby Road.


HOPKINSON-FERRANTI
HOPKINSON VALVES
7902
ABOVE
ALL OTHERS
J.HOPKINSON & Co LTD., HUDDERSFIELD.

This Sectional Drawing of "4810" Air Hose shows how strength has been built into it. There is no armoured hose so impervious to injury as "4810."

Tests In A Small Shipyard With 4810 AIR HOSE

There is a shipyard in the North that is a model of efficiency. It is a comparatively small yard, but growing rapidly. Ship repairs are a big item of its business—rush work.

Our interest in this yard naturally centres on its pneumatic tool, hose equipment. We are demonstrating the necessity for standardising such equipment—proving by a series of tests that "4810" Air Hose saves money every working hour, speeds up work, betters work, is absolutely reliable—and *pleases the workmen.*

To-day "4810" is getting the hardest gruelling that these shipyard riveters can give it. It is being dragged all over the yard, walked on and driven over, tested at frequent intervals for leakage, soaked with oil, subjected to extremes of temperature.

A week of such tests have failed to find a weak spot in "4810." Six months from now the same hose will be delivering every ounce of air the pumps register.

That is the "4810" way of proving the value of standardisation—the all-embracing economy of adopting one type of efficient Air Hose for *all pneumatic tools*.—"4810."

LET US LAY THE FACTS BEFORE YOU.
A CARD WILL BRING OUR EXPERT.

UNITED STATES RUBBER CO., LTD.
(Formerly INDIA RUBBER PRODUCTS CO., LTD.),
47-48, Farringdon Street, London, E.C. 4.

BIRMINGHAM: 6, Temple Row.
LIVERPOOL: 41-55, Wapping.
GLASGOW: 48-50, Cadogan Street.

Save on every rivet - 4810

8482

G.E.C.

Switchgear

For use in Fiery or Non-Fiery Mines.

G.E.C. Switchgear has been specially designed to meet the Home Office Regulations.

The importance of suitable switchgear for mine and colliery installations cannot be too strongly emphasised, and its selection requires very careful consideration.

In the special series of Switches, Circuit Breakers, &c., designed and manufactured by the G.E.C., every mining demand has been scrupulously met.

G.E.C. switchgear is of extremely robust construction,

EXPLOSION & FLAME PROOF,

having heavy machined flanges, which reduce to a safe temperature any escaping gases due to an internal explosion.

The G.E.C. confidently recommend their Ironclad Switchgear for the consideration of Colliery Engineers.

Write for full particulars.

The General Electric Co., Ltd.,

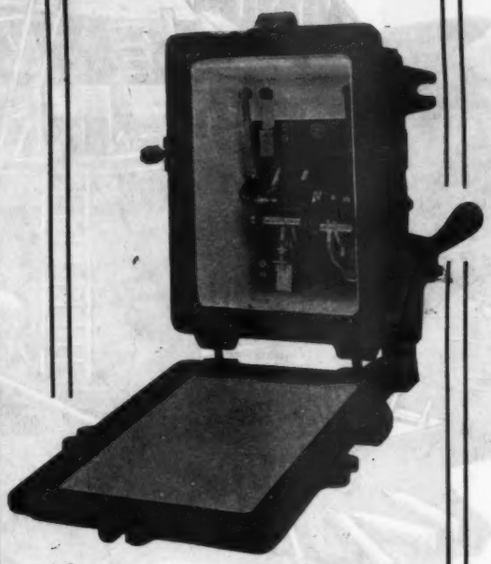
Head Office:
67, QUEEN VICTORIA STREET, LONDON, E.C. 4.

Telephones: London Wall 3600 (36 lines).
Telegrams: "Electricity, Cent, London."
Engineering Works { Witton, Birmingham; Fraser & Chalmers Engineering Works, Erith, Kent.

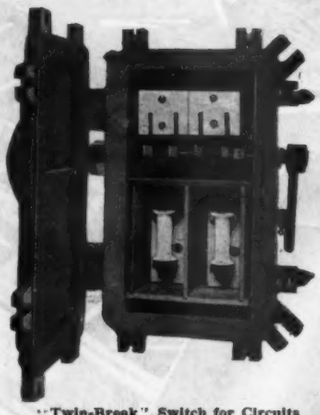
Branches throughout the United Kingdom.

REGD TRADE MARK. REGD TRADE MARK.

8545



30-amp. 300-volt Explosion Proof Circuit Breaker.



"Twin-Break" Switch for Circuits up to 600 volts.

5-amp. 250 volt Explosion Proof Switch and Fuse.

(A.120)

THE

LONDON ASSURANCE

(INCORPORATED A.D. 1720)

7, ROYAL EXCHANGE, LONDON, E.C.3

1720—1920

FIRE—MARINE
LIFE—ACCIDENT
and all other classes of Insurance

Assets - £8,499,206
Income - £2,970,539

BRANCHES AND AGENCIES THROUGHOUT THE WORLD. APPLICATIONS for AGENCIES INVITED. QUOTATIONS for all kinds of RISKS upon Application.

¶. The Governors and Court of Directors of the London Assurance Corporation send Greetings to all their business friends and connections the world over on the occasion of their Bicentenary Celebration.

¶. Founded by Royal Charter on June 22nd, 1720, this great Corporation, after two hundred years of business life, stands firmly established on the rock of proved merit.

¶. Its history is that of Insurance generally; but with however much justifiable pride its past is recalled, the Corporation, fully conscious of its responsibilities, is constantly effecting improvements compatible with safety.

¶. It will ever be the aim of the London Assurance Corporation, to endeavour to prove their utility to the general public, and thus to hand down to their successors what they received from their predecessors—an organisation second to none for safe and reliable insurance of every kind of business and private risk, satisfactory in all respects to the Assured as well as to the Assurer.

The Corporation has granted Fire, Life and Marine Insurances for

TWO HUNDRED YEARS

HYDRAULIC Variable Stroke PUMPS
PATENT HELE-SHAW SYSTEM and Rotary MOTORS

THE HYDRAULIC TRANSMISSION GEAR
for
SEARCHLIGHT and RANGE-FINDER CONTROL

Transmission of Power by Oil Pressure up to
2,500 LBS. PER SQ. INCH

HYDRAULIC GEARS LTD.

Contractors to H.M. ADMIRALTY and WAR OFFICE

BEAVOR LANE, HAMMERSMITH, LONDON, W. 6. 8807

Telephone: HAMMERSMITH 1933 & 1934

Telegrams: "HYGEARLIM, PHONE" LONDON

Directors:
S. GLUCKSTEIN · G.W. BOOTH · G.W. OATLEY.
H.H. MACTAGGART · W. G. RIDDELL, O.B.E.

Telephone: Gerrard 8887. Telegrams: "Lowtemcar, 'phone, London."

LOW TEMPERATURE CARBONISATION LTD.,
14/16, Cockspur Street, London, S.W. 1.

CAPITAL - £1,200,000

(The Pioneers of the Low Temperature Carbonisation of Coal).

We have expended over £1,000,000 in research and we are now prepared to *Construct and Operate Plants* of any size for the Low Temperature Carbonisation of Coal.

Complete recovery of all By Products.

1. Perfect Domestic Smokeless Fuel.
2. More Oil per ton than any other known process.
3. Double the usual yield of Pure Motor Spirit.
4. High Quality Gas at low cost.
5. Sulphate of Ammonia.

Full treatise sent on application.

LOW TEMPERATURE CARBONISATION Ltd.,
14/16, COCKSPUR STREET, LONDON, S.W. 1. 7923

"CORONA"

BEST BRITISH MAKE

Spirit Blow Lamps
Paraffin Brazing Lamps

"CORONA" Blow Lamps and Brazing Lamps have excellences not obtained in other makes. The Oil Container or Reservoir is made of heavy gauge, highly-polished non-porous brass. The Burner is made of specially hardened material of great durability. The very efficient vapourizing system reduces carbonization to a minimum, thus further prolonging the life of both the Burner and the Nipple, and incidentally increasing the heat intensity of the flame, besides reducing considerably the oil consumption. Great care is exercised in the brazing of all joints, and each Lamp is thoroughly tested under a pressure far in excess of its standard in ordinary use.

"CORONA" Lamps are made in varying sizes, ½ to 50 pints, in all patterns for all purposes. For Plumbers, Painters, Electricians, Engineers, Coppersmiths, Railway and Ship Yards, etc.

Our illustration shows one of the very wide range of "CORONA" Blow and Brazing Lamps.

BURNING PARAFFIN OIL.

"Corona" Nos. 112 and 115.
Fitted with Pump and Pressure Gauge.

RETAIL PRICES:

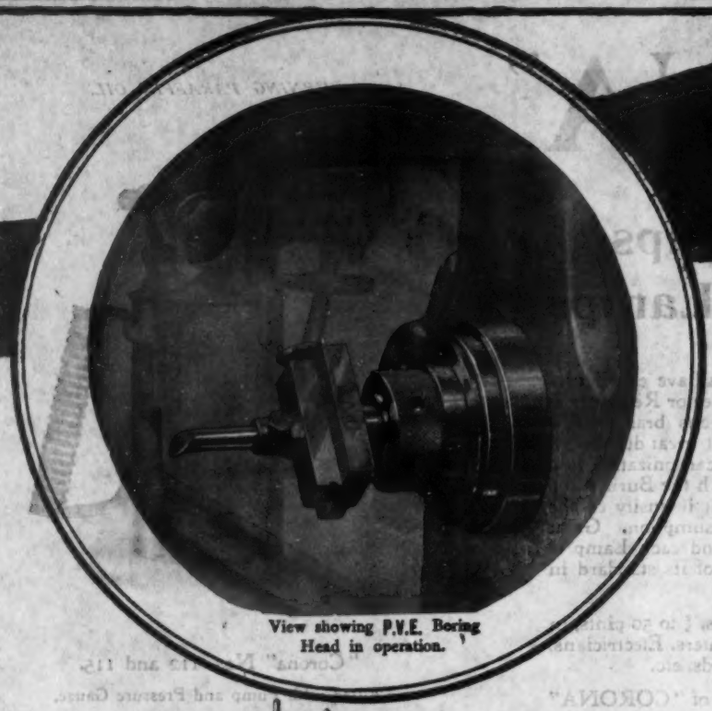
No. 112 Holds 2½ pints - 75/-
No. 115 ,, 5 ,, - 87/6

HOWES & BURLEY LTD.
BIRMINGHAM.

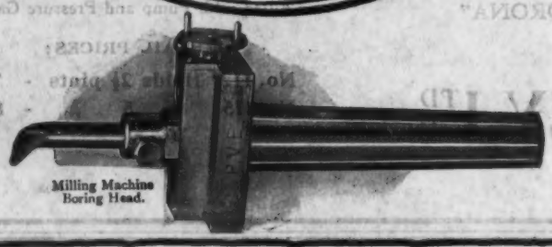
8405

CARRUTHERS
MARINE AUXILIARIES

8406



View showing P.V.E. Boring Head in operation.



Milling Machine Boring Head.

The P.V.E. Milling Machine Boring Head

THE P.V.E. Milling Machine Boring Head is well made and of rigid design. It has a boring capacity of from $\frac{5}{16}$" hole to 6" hole.

We have used a similar head in our own Shops for some years for jig and other boring operations on Milling Machines with very satisfactory results, and we have every confidence in recommending it for general use.

With the addition of a "tappit" wheel in place of the small graduated handle this tool can be used for facing.

We invite enquiries for all classes of Gauge, Jig and Press Tools executed to your own requirements.

WRITE TO-DAY TO THE PRECISION TOOL DEPT.

PITTERS' VENT AND ENGINEERING COMPANY LTD.
WOOLWICH
S.E. 18.

8823

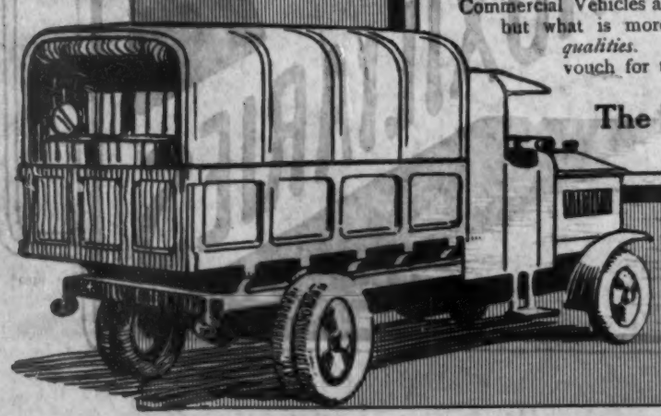
Mobile Publicity

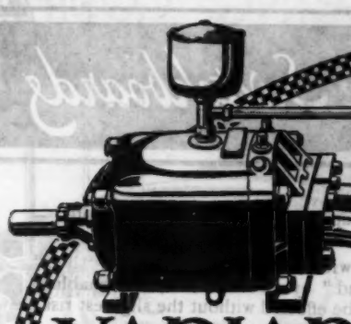
Your lorries do more than cope with your problems of road transport. They are a part of your publicity. And not too indirectly so, either. Your private car plays no small part in reflecting your personal standing. In precisely the same way, your commercial vehicles tend to indicate on what plane your business stands. The

MAUDSLAY

Commercial Vehicles are very powerful, very strongly built, and very reliable; but what is more, *they actually have the appearance of possessing those qualities.* Anyone who has taken note of a "Maudslay" will vouch for that. Let us tell you also about its great accessibility.

The Maudslay Motor Co., Ld., Coventry.



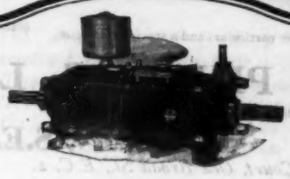


The
WILLIAMS-JANNEY
(MANUFACTURERS VICKERS LIMITED.)

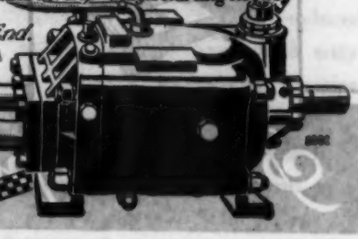
HYDRAULIC VARIABLE SPEED GEARS

for— SHIPS STEERING GEARS, CRANES, CAPSTANS, WINDLASSES, WINCHES & HOISTING APPLIANCES; MACHINE TOOLS.

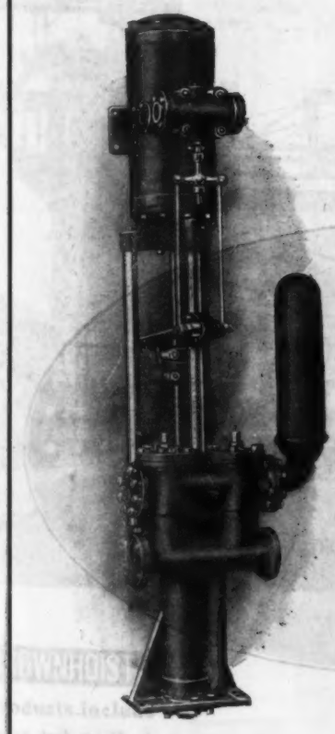
Suitable for any purpose where it is desired to convert a constant speed in one direction into an infinitely variable speed in either direction and to develop a high starting torque.



TYPE C.
These Machines are made in 9 Sizes capable of transmitting from 2 to 200 H.P.



For All particulars apply to
The VARIABLE SPEED GEAR Limited.
Broadway Court
LONDON, S.W.1.



WORTHINGTON

VERTICAL SIMPLEX FEED PUMP

Specially Designed for

MARINE SERVICE

Small Floor Space - - Simplicity
Adaptability - Few Working Parts

DELIVERIES from STOCK.
— Apply for Leaflet. —

WORTHINGTON-SIMPSON LTD.

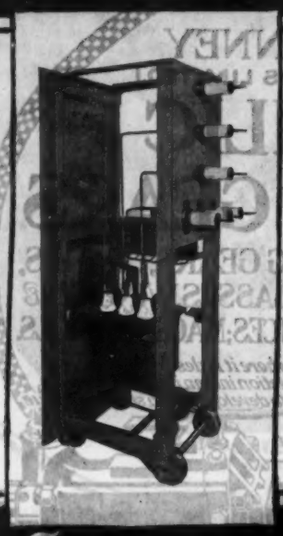
Queen's House, Kingsway, London, W.C. 2.

Telephone: 3048—49—50 HOLBORN.

Works: NEWARK-ON-TRENT.

Telegrams: "PUMPING, WESTCENT, LONDON."

J & P draw-out Truck type Switchboards



Where it is difficult to insure skilled supervision—where space is limited—the J. & P. Truck Type Switchboards are invaluable.

Here we illustrate a truck withdrawn with all those parts, which are "live" before it is removed, rendered "dead" by disconnection, thus enabling repairs, examination and cleaning, to be effected without the slightest risk.

And that entirely obviates the necessity for a passage at the rear, with a consequent economy in space which will be appreciated.

Such advantages should commend this Type of Board to all interested in Electrical Installations.

We would like to send you fuller particulars and a special Catalogue. 8048

JOHNSON & PHILLIPS, Ld.,

Electrical Engineers and Cable Makers since '75.

Charlton, LONDON, S.E. 7.

City Office: 12, *Union Court, Old Broad St., E.C.* 2.

Save space labour and risk

PREMIER GAS ENGINES

Premier Multi-cylinder Gas Engines, with their excellence of design and perfect system of governing, are ideal for installations where low cyclic variation is essential, including the driving of direct coupled alternators in parallel.

They are recommended also for driving large Pumping Plants, Textile Factories, Flour Mills, etc.

In addition to their steady running, Premier Engines have the advantages of low fuel consumption, accessibility and reliability.

PREMIER GAS ENGINE Co., Ltd.,
(CROSSLEY BROTHERS Ltd.)
SANDIACRE - Nr. NOTTINGHAM.

8552

4 cylinder Premier Gas Engine of 840 B.HP. direct coupled to 500 Kw. Dynamo
The Kawasaki Dockyard and Engineering Co., Ltd., Kobe, Japan.

P.1.

The distribution of B. S. A. Drills is specialized no less than their manufacture. We are the Sole Selling Agents and our whole organization is concentrated on the SUPPLY of high-class tools—from engineers' and workshop tools to the largest machine tools for mass production purposes. Send us your enquiries.

Burton Griffiths

& CO., LTD.,

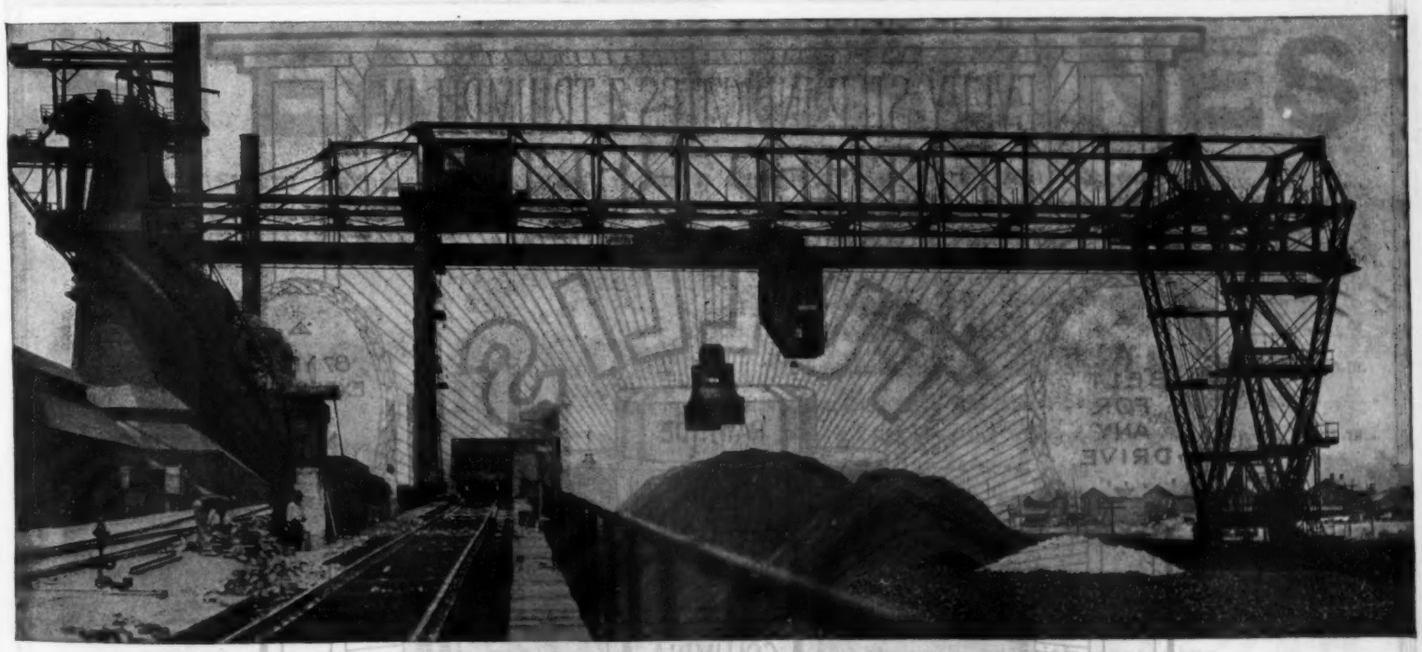
1, LUDGATE SQUARE, LUDGATE HILL, LONDON, E.C. 4.

And at BIRMINGHAM, MANCHESTER, and GLASGOW.

a specialists job—

8397

THE production of High Speed Twist Drills, from the selection and analysis of the raw material to the final gauging of the finished drill is the work of specialists. Only in a modern factory equipped with laboratories, scientific methods of manufacture, and special testing machinery, can drills of the accuracy, speed and durability of B.S.A. Twist Drills be produced. All these factors, combined with sixty years' experience of engineering practice go to the making of B.S.A. HIGH SPEED TWIST DRILLS and their wide spread popularity among the large engineering firms is the best proof of their efficiency and economy in operation.



BROWNHOIST

Products include

Heavy dock machinery.
Coal & ore bridge cranes.
Locomotive cranes.
Grab & drag-line buckets.
Overhead travelling cranes.
Tramrail systems.

Write for Catalogues.

2021

Handling Ore at the Furnace.

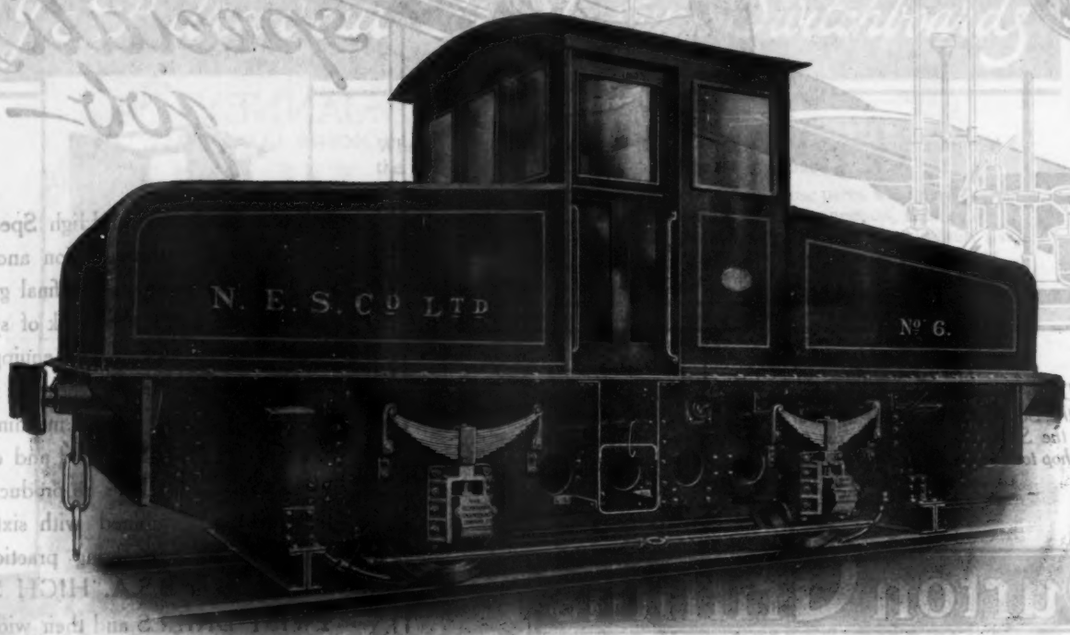
This Brownhoist bridge is used at a large American steel plant for handling ore, stone and coke in and out of storage and to the furnace. It has effected a great saving in time, money and labour.

Brownhoist reputation for dependability is the result of 40 years' experience in solving handling problems. And Brownhoist engineers will gladly give you the benefit of their experience with handling machinery. Just write our European representative, H. E. Hayes, 12, Rue de Phalsbourg, Paris, if you have any kind of a handling problem.

The Brown Hoisting Machinery Company,

40 Years in Crane Business. **Cleveland, Ohio, U.S.A.**

THE KILMARNOCK ENGINEERING COMPANY, LIMITED.



10, COLEMAN STREET,
LONDON, E.C. 2.

Works:
BRITANNIA WORKS,
KILMARNOCK, N.B.

EVERY STEP INDICATES A TRIUMPH IN
LEATHER BELTING

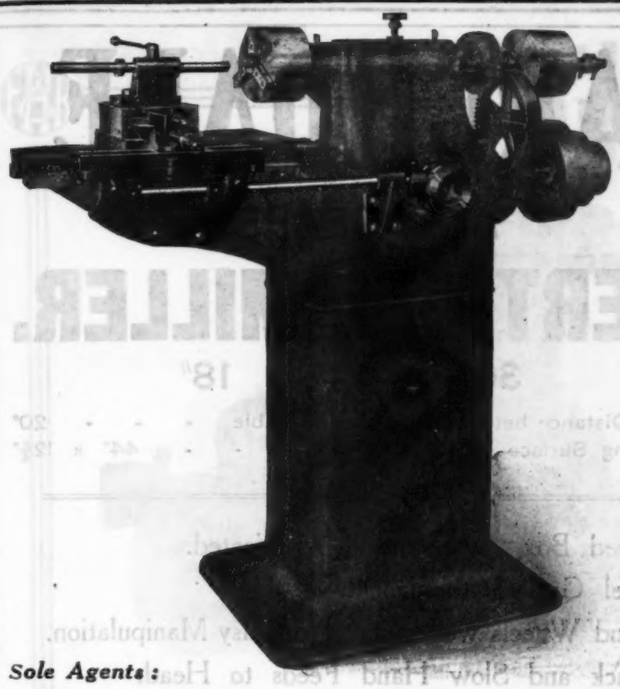
TULLIS

A BELT FOR ANY DRIVE

87 YEARS EXPERIENCE IS AT YOUR SERVICE

RAWHIDE
CHROME
ORANGE TAN
COLUMBIA
STANDARD OAK

JOHN TULLIS & SON. LTD ST ANN'S WORKS GLASGOW



Fischer Automatic Oil Grooving Machine

CAPACITY 10 in. over the carriage and a stroke of 0 to 8 in. WILL cut straight or spiral grooves and will handle from five to ten times the amount of work that is possible by any other method.

Illustration shows machine equipped with Relieving Attachment and Air Operated Chuck.

Write for prices and specification.

Sole Agents:

COATS MACHINE TOOL COMPANY, LTD.,

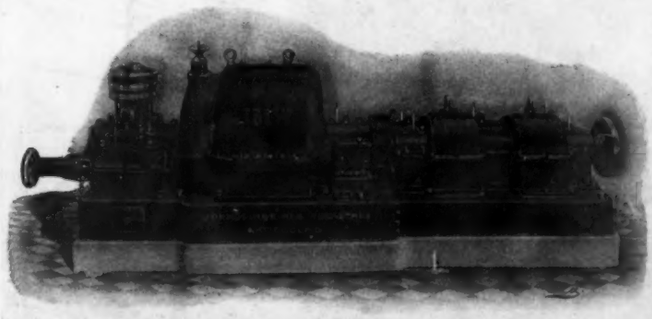
14, Palmer St., Westminster, London, S.W. 1. 8604

'Phone: Victoria 2518 and 1509. **Telegrams: "Oolcomachi, Vic., London."**

Also Sole Agents for—SHORE INSTRUMENT & MFG. Co., Jamaica, N.Y.; INTERNATIONAL MACHINE TOOL Co., Indianapolis, Indiana; CLARK EQUIPMENT Co., Buchanan, Mich.; W. B. KNIGHT MACHINERY Co., St. Louis, Mo.; HANNIFIN MFG. Co., Chicago, Ill.; MURCHEY MACHINE AND TOOL Co., Detroit, Michigan; MINSTER MACHINE Co., Minster, Ohio, Mo.

STEAM TURBINES

Steam Turbines of the most modern design and construction, embodying high-class workmanship, and of low steam consumption are offered for short delivery, and a few sizes from stock for prompt delivery:

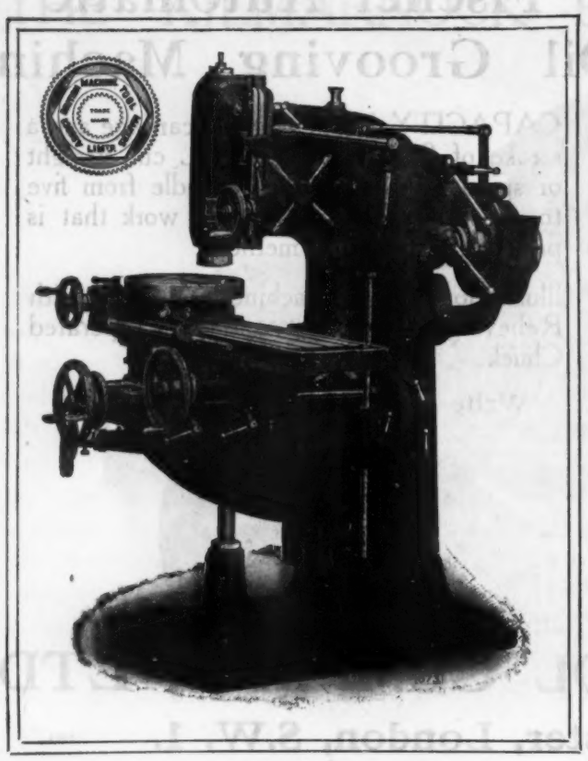


ONE 450 h.p. Condensing with Steam Extraction. 3000 r.p.m.
ONE 750 h.p. Condensing. 3000 r.p.m.
ONE 750 h.p. Condensing and with reduction gear. 3600/900 r.p.m.
ONE 900 h.p. Condensing with Steam Extraction. 3000 r.p.m.
TWO 1500 h.p. Condensing and with reduction gear. 3000/750 r.p.m.
ONE 2000 h.p. Condensing. 3000 r.p.m.
FOUR 2250 h.p. Condensing. 3000 r.p.m.
TWO 3600 h.p. Condensing. 3000 r.p.m.
TWO 4500 h p. Condensing. 3000 r.p.m.

All of the above Turbines are equipped with surface condenser and necessary pumps. The Turbines may be used for steam with pressures up to 215 lbs. per square inch, and superheated to 615° F. Exceedingly favourable terms for purchasers concluding contracts without delay. 8596

JÖNKÖPINGS MEK, WERKSTADS A./B.

JÖNKOPING, SWEDEN.



No. 673.

ARCHDALE

ALL GEARED

VERTICAL MILLER.

30″ x 12″ x 18″

Max. Distance between Spindle and Table - - - 20″
Working Surface of Table - - - - 44″ x 12¾″

Speed Box Automatically Lubricated.
Steel Gearing throughout.
Hand Wheels well grouped for Easy Manipulation.
Quick and Slow Hand Feeds to Head.

SIMPLE MANIPULATION. 6966

J. ARCHDALE & CO., Ld.,
Ledsam Street, BIRMINGHAM.

THE DARLINGTON FORGE LTD.,

Telegrams: "Forge, Darlington." DARLINGTON, ENGLAND. Telephone No. 2618.

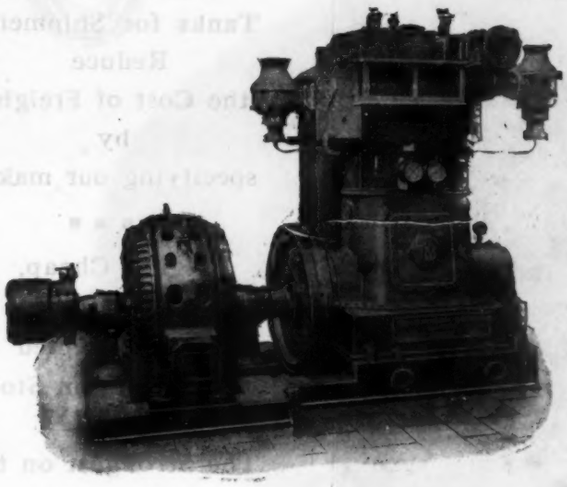
STEEL & IRON FORGINGS, STEEL CASTINGS.

Up to any size or weight.

3-THROW MILL ENGINE CRANKSHAFT.
23 in. diam. by 31 ft. 6 in. long. Finished Weight, 40-tons.

REPAIR WORK A SPECIALITY. 7864

Fullerton



AIR COMPRESSOR

SPECIAL FEATURES:

High Efficiency; Economy in Maintenance and Running; Simplicity of Design; Accessibility of all Working Parts; Patent Automatic Plate Type Air Valve; Patent Unloading System; Smooth Running at High Revolutions.

ALL SIZES OF COMPRESSORS FROM 50 TO 10,000 CUBIC FEET CAPACITY.

FULL PARTICULARS ON APPLICATION.

8616

Fullerton, Hodgart & Barclay, Ltd
PAISLEY

ESTABLISHED 1838.

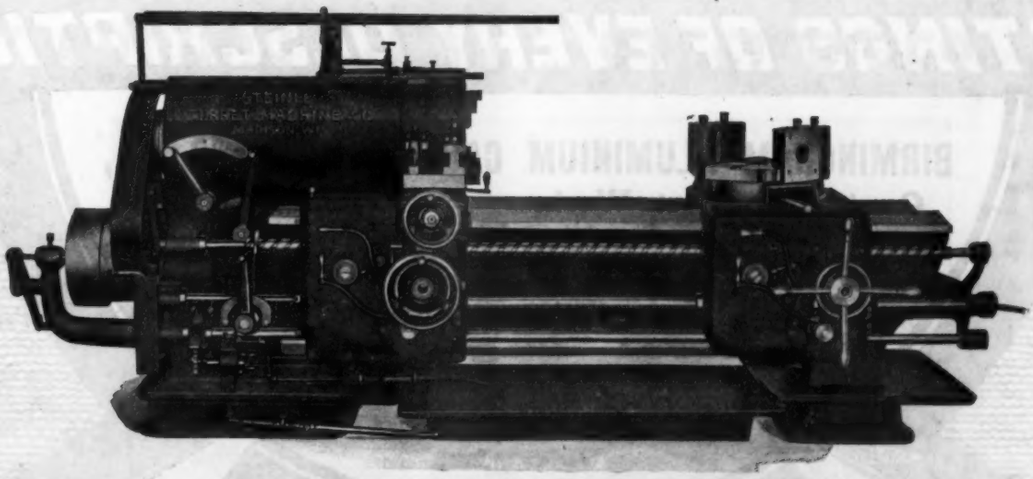
Codes: A B C 5th Edit., Engineering, Western Union, Marconi Inter.

Telephones: 2163-4 Paisley. (Private Branch Exchange). Telegrams: "Vulcan, Paisley."

A GENERAL PURPOSE TURRET LATHE

STEINLE TURRET MACHINE COMPANY,

Madison, Wisc., U.S.A.



Standard belt driven 24 in. Lathe. Furnished either with 4in. or 6½ in. spindle bore and with standard or special tool equipment. 8669.

This Lathe is designed to give continued satisfaction, and will stand up under the most trying conditions demanded by continued rapid production.

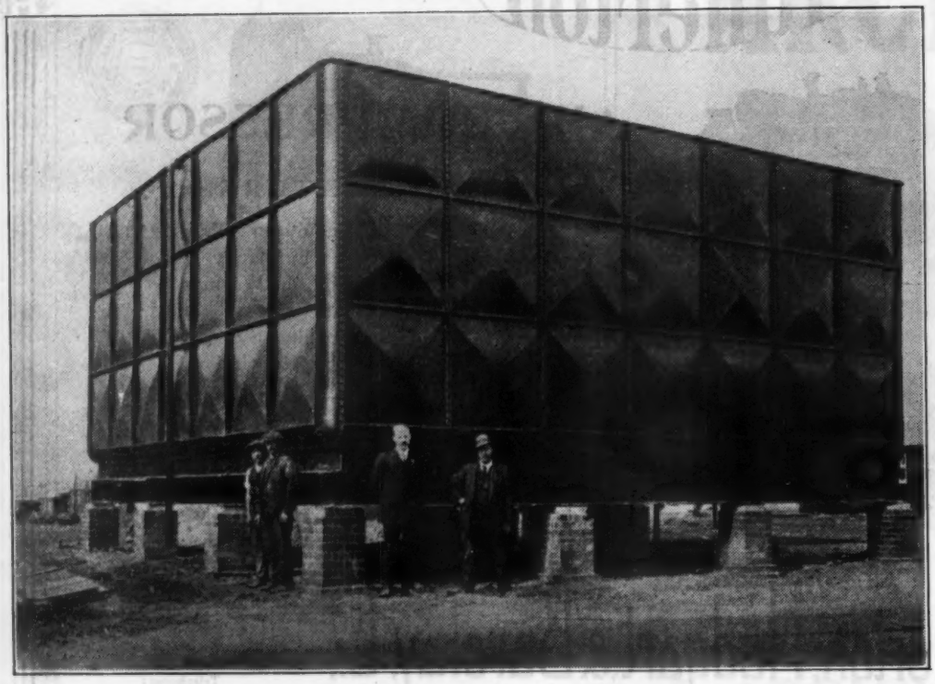
Write for complete information—Illustrated Catalogue and Prices.

LEO C. STEINLE,

53, VICTORIA STREET, LONDON, S.W.1.

GUEST-LENOX PATENT PRESSED STEEL SECTIONAL TANKS

As Supplied to H.M. War Office and Admiralty.



When Ordering
Tanks for Shipment,
Reduce
the Cost of Freight
by
specifying our make.

Light, Cheap,
Bolted Joints,
Easily Erected
Delivered From Stock,
and
The Strongest on the
Market.
Over 4,000 tons supplied.

Sole Makers: **BROWN, LENOX & CO., (LONDON), LTD., POPLAR, E.**

CABLEGRAMS ... ... "LENOX, MILLWALL." 8364

ALUMINIUM

CASTINGS OF EVERY DESCRIPTION.

BIRMINGHAM ALUMINIUM CASTING (1903) CO. LD.,
Cambridge Street Works - - BIRMINGHAM.

SAND AND DIE CASTINGS
of the Highest Quality for 7084
General Engineering,
Automobile
and
Aeronautical
Work.

THE BUTLER SLOTTER LEADS

Tel. Address:
BUTLER, HALIFAX.
Telephone No. 1013.

THE BUTLER MACHINE TOOL Co., LTD.,

Victoria Iron Works,
HALIFAX

ESTABLISHED 1868.

Specialists in Reciprocating Machine Tools, Planers, Slotters & Shapers.

THE SCOTTISH TUBE CO., LTD.

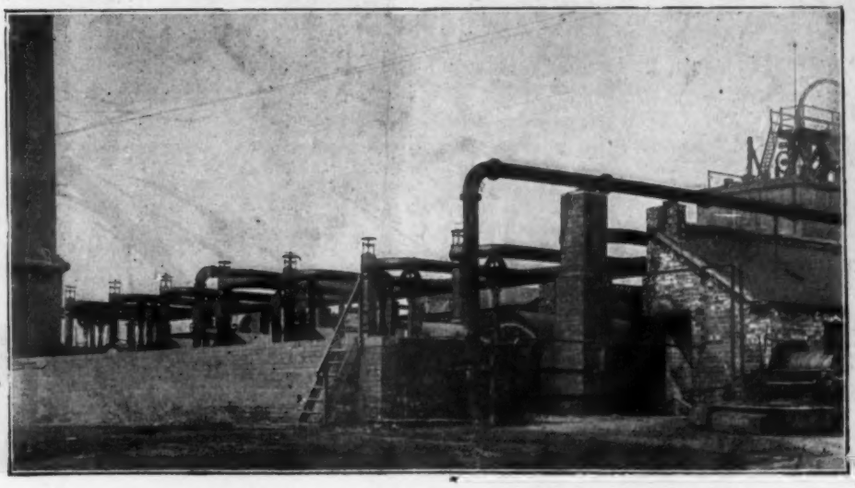
Head Office: 34, Robertson Street, GLASGOW.

BRANCH OFFICES—LONDON, MANCHESTER, LIVERPOOL, NEWCASTLE-ON-TYNE, CARDIFF, SYDNEY, WELLINGTON, N.Z., JOHANNESBURG.
WORKS—GLASGOW, GOVAN, COATBRIDGE, RUTHERGLEN and GARNKIRK.

MANUFACTURERS OF

WROUGHT-IRON AND STEEL PIPES.

BOILER TUBES



Gas, Water and Steam TUBES and FITTINGS.

Boring and Casing TUBES.

PIPES for Welding into Continuous Mains.

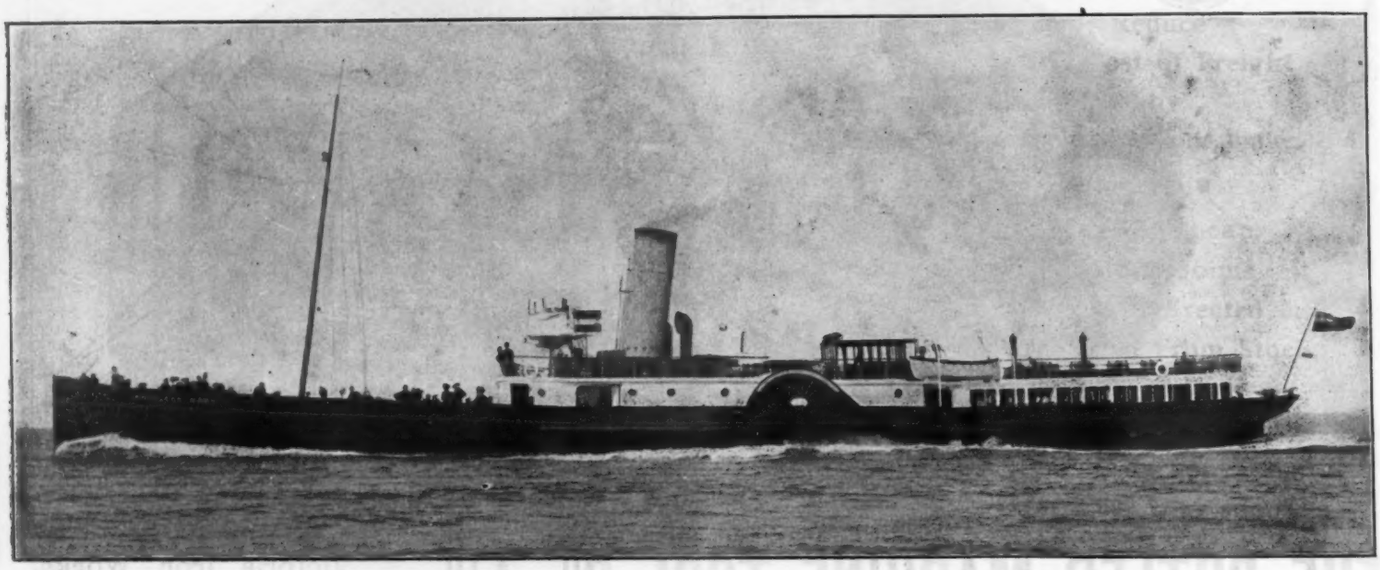
Main Steam Pipe Installation supplied and erected at the Methly Junction Colliery o
Messrs. Henry Briggs, Sons & Co., Ltd.

Telephone—No. 5687 CENTRAL (Six lines). Telegraphic Address—SCOTUBECO, GLASGOW.
Codes—A1, A B C (4th and 5th Editions), Liebers, Western Union, and Private.

DAY, SUMMERS & CO., Limited,

ENGINEERS, BOILERMAKERS, SHIP & YACHT BUILDERS. **Northam Iron Works, SOUTHAMPTON.**

Telephone—No. 48. Telegrams—"DAY, SUMMERS, SOUTHAMPTON."



P. S. "PRINCESS MARY." 553 Tons. I.H.P. 1000 Designed and built by D., S. & CO., Ltd.

8331

Specialities:—STEAM TRIPOD TRAVERSING SHEERS (Land and Floating), and HAULING-UP SLIP MACHINERY.

TELEGRAMS—WERFCONRAD, HAARLEM, DREDGCRAFT, AVE., LONDON.
CODES—LIEBERS, A.B.C. 5th Ed. and MORRING & NEAL.
TEL.—CITY, 257.
Agents: MARINE WORKS, Ltd.,

WERF CONRAD, HAARLEM, HOLLAND.

FRIARS HOUSE, 39-41, NEW BROAD STREET, LONDON, E.C. 2.

DREDGING PLANT

OF THE LATEST AND MOST IMPROVED TYPES, OF ALL DESCRIPTIONS, AND UP TO THE LARGEST DIMENSIONS AND CAPABILITIES.

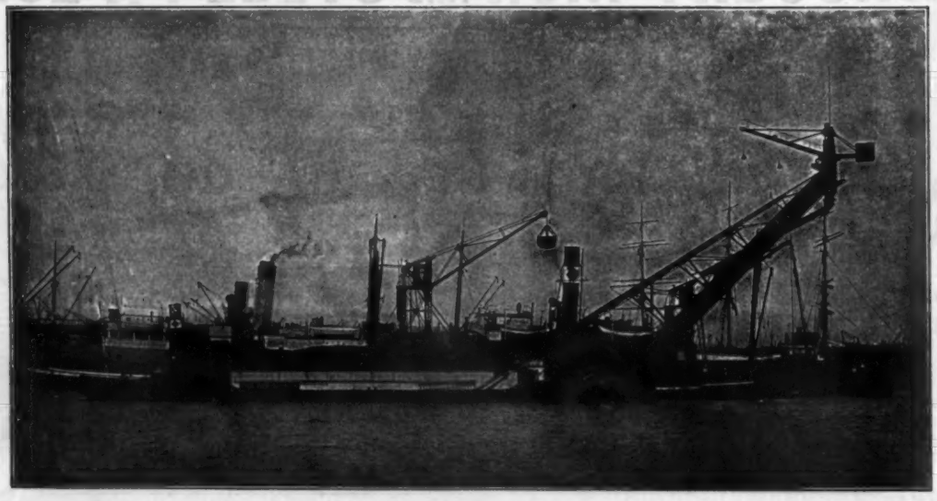
BARGES AND FLATS BUILT IN SECTIONS FOR RE-ERECTION ABROAD.

BUCKET HOPPER AND BARGE-LOADING DREDGERS.

SUCTION PUMPING DREDGERS.

COMBINED BUCKET AND PUMP DREDGERS

SUCTION CUTTING DREDGERS for DREDGING CLAY, &c.



COAL BUNKERING VESSEL, built for Rotterdam Harbour. Carries 800 tons.

FLOATING CRANES.

COAL BUNKERING VESSELS.

HOPPER BARGES of any capacity.

SPARE PARTS and RENEWALS supplied.

GOLD AND TIN RECOVERING DREDGERS A Speciality.

8491

DESIGNS, QUOTATIONS, AND ALL DETAILED INFORMATION, BOTH AS TO DREDGING PLANT AND DREDGING GENERALLY, AND UPON ALL QUESTIONS AFFECTING THE RECOVERY OF GOLD, PLATINUM AND TIN, ON APPLICATION.

Growth.

THE secret of the increased sales of Apex productions is easily explained by the facts we have brought to your notice in recent advertisements. Quality assured by the laboratory, and right prices with quick deliveries. May we suggest that you send us a trial order and thus prove our SERVICE?

Have you had your copy of our Catalogue? If not, send a P.C. to-day to Dept. "E."

AGENTS:

LONDON: PICKETTS, LIMITED,
22, Henrietta Street, W.C. 2.
Telephone: Gerrard 3682. Telegrams: "Pickettian, Rand, London."

MANCHESTER: T. W. ETCHELLS,
Queen's Chambers, 5, John Dalton Street.

SCOTLAND: BURNS, MORRISON & CO.,
13, St. Vincent Street, GLASGOW.

APEX STEEL COMPANY, LTD
Penistone Road, SHEFFIELD.

MILLS CASTINGS

ALUMINIUM CASTINGS—the product of the foundry with the longest experience in casting Aluminium. Send your drawings. Our laboratory will specify the right alloy—and we will make the patterns if required.

ALUMINIUM CASTINGS
CAST IRON CYLINDERS
WATER AND AIR COOLED

CAST IRON CYLINDERS—in any size and quantity and of a calibre which can only be produced in well-organised works laid out with the wealth of knowledge which comes from long years of experience.

WILLIAM MILLS Ltd.

Aluminium and Iron Founders,
GROVE STREET, BIRMINGHAM.

8080

NEWALLS
MAGNESIA COVERING
For BOILERS, TURBINES, &c.
NEWALLS INSULATION Co., Ltd.,
21, MOSLEY STREET, NEWCASTLE-ON-TYNE.

PURE WATER
for all purposes,
Particulars from 4961
The BUHRING'S Patent WATER PURIFYING Co.,
60, Wilson Street, E.C.

ATLAS PNEUMATIC TOOLS.
8051
ATLAS DIESEL CO., LTD.,
35, SURREY STREET, W.C. 2.

SANKEY
Foundry Ladles
Pressed Steel
Joseph Sankey & Sons Ltd
Wellington Shropshire

The TIMBRELL & WRIGHT MACHINE TOOL & ENG. CO., Ltd.,
Slaney Street, Birmingham.
T. & W.
CAPSTAN LATHES.
See our Fortnightly Advertisement. 6883

GLENFIELD & KENNEDY LTD.
Engineers & Ironfounders,
KILMARNOCK, 7890
SCOTLAND.
SEE ADVT. LAST AND NEXT WEEK'S ISSUE.

THE HULL GENERAL PATTERN-MAKING WORKS,
58, Strawberry St., Drypool, HULL.
Quotations given for every description of
PATTERN MAKING
for Engineers, Iron and Steel Founders, Shipbuilders, &c. 8534
ON ADMIRALTY LIST. Central Telephone 107 Y

BELLISS & MORCOM,
BIRMINGHAM. LTD.
Self-lubricating Steam Engines, Turbines, Air and Gas Compressors, Condensing Plants, Heavy Oil Engines and Paraffin Engines.
See Illustrated Advt. every month. 6668

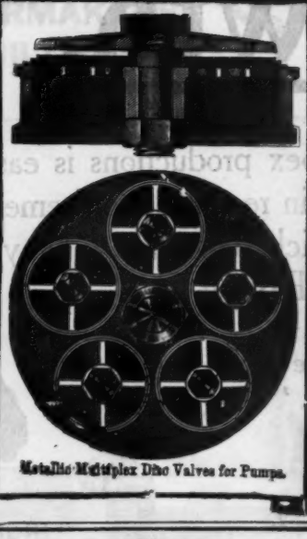
BRUNDRIT PATENT Temperature Balance
SEE LAST OR NEXT ISSUE
FOR Marine & Land BOILERS
J. BRUNDRIT 14 Water St. LIVERPOOL

THE VAUGHAN CRANE Co., Ltd., Manchester.
Travelling Cranes—Runways—Pulley Blocks.

Paper Mill Machinery
BERTRAMS LIMITED

THE SCOTTISH STAMPING & ENGINEERING CO. LD.,
Drop Forgers and Stampers, 8140
NEPTUNE WORKS, AYR.
See last and next week's Illustrated Advert.

THE METALLIC MANUFACTURING Co LTD
ARDROSSAN


Metallic Multiplex Disc Valves for Pumps.

Telegrams: "Jointing, Ardrossan." Telephone: No. 91 Ardrossan.
Glasgow Office: 54, GORDON ST. London Office: 104, MINORIES, E.
Contractors to H.M. Government.
MANUFACTURERS OF
Metallic Disc Valves for Pumps.
Corrugated Metallic Valves for Pumps.
Corrugated Metallic Jointing Rings.
Seamless Copper Jointing Rings.
Copper and Asbestos Jointing Rings.
Manganese Jointing Paste.
Fibrous Metallic Packing.
OUR METALLIC VALVES ARE AT PRESENT IN USE IN OVER 200 WARSHIPS IN THE BRITISH NAVY

Corrugated Metallic Joints for Steam, Hydraulic, Oil, and Blast Pipe Joints.

Drills
IMMENSE STOCK OF CARBON AND HIGH SPEED DRILLS.
ENGINEERS' TOOLS OF EVERY KIND.
TUCK & BLAKEMORE L[D]
Coventry.
6267

Greater Production and Better Results
The AEROGRAPH distributes the heaviest enamel, paint, varnish, and other pigments far more smoothly and evenly than, and in a fraction of the time taken by, the old brush methods.
For painting Ships, Bridges, Wagons, Machinery, Aeroplanes, Motor Cars, Houses, and all kinds of Iron and Wood work, the greatest speed, economy and efficiency are obtained by the use of
The Aerograph
REG[D] TRADE MARK
8481
Thickness of coating adjustable to a nicety at will of operator.
Catalogue and full information post free.
THE AEROGRAPH CO., Ltd., 43, HOLBORN VIADUCT LONDON, E.C. 1.
BRITISH FROM THE FIRST.

STEEL & IRON FORGINGS

SPECIALITIES

BUILT CRANKSHAFTS FINISHED COMPLETE

TUNNEL SHAFTING ROUGH TURNED AND FINISHED COMPLETE WITH BOLTS & NUTS

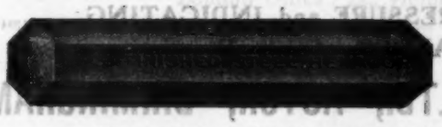
PROPELLER SHAFTS FORGED FROM PURE SCRAP IRON INGOT STEEL OR NEW BAR IRON TURNED & FINISHED COMPLETE WITH GUN METAL LINERS

THE FIFE FORGE COMPANY, LTD KIRKCALDY, SCOTLAND.

ON ADMIRALTY & WAR OFFICE LISTS

"Columbia" Bright Cold Drawn Mild Steel Rounds, Squares, Hexagons, Flats, and Special Shapes.

Free cutting, uniform throughout, and true to size. Special case hardening quality. Supplied well greased in 5 cwt. cases.



"Columbia" Turned and Polished Shafting.

All bars absolutely true to gauge and accurately straightened.

Telegrams: Integral, Holb., London.
Telephone: No. 1562 Holborn.

COLUMBIA STEEL & ENGINEERING Co., Ltd., 334-6, Bank Chambers, 329, High Holborn, London, W.C.1.

WHY IS IT ? ? ?

+GF+

Malleable Tube Fittings have the largest sale of any fittings.

If you will try a sample lot you will soon know the reason why.

+GF+ One grade only for GAS, STEAM, AND WATER. OVER 7500 VARIETIES. $\frac{1}{8}$ to 6"

GUARANTEE EVERY FITTING IS GUARANTEED TESTED TO 300 LBS. Send for Catalogue.

EDWARD LE BAS & CO., Dock House, Billiter Street, LONDON, E.C.

LONDON, GLASGOW, MANCHESTER, BELFAST.

CHADBURN'S

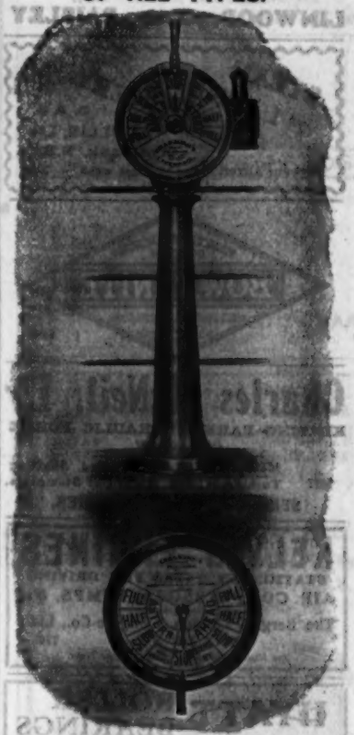
(Ship) Telegraph Co., Ltd.,

PATENT

"DUPLEX" GONG TELEGRAPHS

Fitted on over 20,000 Vessels.

TELEGRAPHS FOR STEAMERS OF ALL TYPES.



DECK TRANSMITTER.

PATENT SPEED AND DIRECTION TELLTALES FOR TURBINES.

GLASGOW: 4, Finnieston Quay.
WALLSEND-ON-TYNE: 2, Gainers Terrace
BELFAST: 39, Donegal Quay.
LONDON: 108, Fenchurch Street.
HULL: 38, Charlotte Street.
SOUTHAMPTON: 25, Oxford Street.

HEAD OFFICE AND WORKS —
CYPRUS ROAD, BOOTLE, LANCS.

H. W. WARD & Co., Ltd.
Lionel Street, BIRMINGHAM. 6051
MACHINE TOOLS
Telegrams—Drake, Birmingham. Tel. No. 7020 Central.
See illustrated Advertisement last and next week.

Machine Cut Gear Wheels
THE REID GEAR CO., 7961
LINWOOD, near PAISLEY

STEAM LAUNDRY MACHINERY.
D. & J. TULLIS, Ltd.,
Clydebank, N.B.
See our Advert. page 127, last week. 7908

BOWRANITE
THE BEST KNOWN SUBSTITUTE FOR BRASS
8445

Charles McNeil, Ltd.,
KINNING PARK HYDRAULIC FORGE
GLASGOW.
Makers of Heavy Forged Shafting
7611 Turbine Wheels, Motor Car Stampings.
SEND US YOUR ENQUIRIES.

KELVIN ENGINES
STATIONARY TYPES FOR DRIVING
AIR COMPRESSORS, PUMPS, &c.
The Bergius Launch & Engine Co., Ltd.,
GLASGOW. 7763
See Illustrated Advt. Last Week or Next.

~~HYATT~~ ROLLER BEARINGS
Suitable for all applications.
See our displayed advertisement next week.
(CATALOGUE "E") 8120
HYATT Ld., 34, DEVONSHIRE STREET, LONDON, W.C. 1.
Wires—"Hyrollin, Phone, London." Phone—Museum 3745

THE **DRUM** PUMP

WRITE FOR DESCRIPTIVE CATALOGUE 119
NO VALVES TO GET OUT OF ORDER. POSITIVE ACTION
THE DRUM ENGINEERING CO. 28, HUMBOLDT ST. BRADFORD.

"GUNTNER"
FANS
For Forges, Cupolas, &c.
CENTRIFUGAL
PUMPS.

W. GUNTNER and SONS, CENTRAL WORKS, GILDHAM.

PHOSPHOR BRONZE, GUNMETAL AND BRASS CASTINGS. 8851
HIGH-CLASS STEAM FITTINGS.
Specialty—SHIPS' DECK FITTINGS
JOHN McROBIE & SONS,
94, Elliot Street, GLASGOW
On Admiralty List. Telephone: CENTRAL 1241
North East Coast Representative: CHAS. RUTHERFORD
North Eastern Bank Chambers, Middlesbrough

THE WELDLESS STEEL TUBE CO., LTD.
Icknield Port Road, BIRMINGHAM.

On Admiralty List. 9611 **Estd. 1872.**
PATENT WELDLESS STEEL TUBES.
For Boilers, Hydraulic Presses, Pumping, Boring Rods, Bushes, Shafting and General Engineering Uses.
Weldless Tubes.

ESTABLISHED 1853.
GAUGE GLASS PROTECTORS.

"EUREKA"
GAUGE GLASSES
MAKERS OF THE NEW GAUGE GLASS
"S. H. P."
FOR SPECIAL HIGH-PRESSURE BOILERS.
STEAM GAUGES
PRESSURE and INDICATING GAUGES of all Descriptions. 7384
JOSEPH TOMEY & SONS, LTD., ASTON, BIRMINGHAM.
London Office and Warehouse: 5, Exchange Parade, Southwark St., London, S.E.

V PILOT PACKINGS
FOR HIGH STEAM PRESSURES
Sole Patentees and Manufacturers
The
BELDAM
PACKING & RUBBER CO., LTD.
29, Gracechurch Street,
LONDON, E.C. 3.
Works—
BRENTFORD MIDDLESEX.
Grams: "Corrugated, Lad., London."
'Phone: Avenue 5204. Code: A B C, 5th Edition.
STOCKS held at Branches
LIVERPOOL, GLASGOW, CARDIFF, NEWCASTLE, SOUTHAMPTON, BRISTOL, LEITH,
and principal Ports throughout the World.

THE METALLIC BEARING SURFACE IS A SINGLE FLEXIBLE WHITE METAL BAR. 8639

IRON ROOFS & BUILDINGS
CONSTRUCTIONAL IRONWORK
TANK MAKERS & GALVANIZERS
JOSEPH ASH & SON
REA STREET SOUTH
BIRMINGHAM
GENERAL IRON & STEEL PLATE WORKERS
OXY-ACETYLENE WELDING

J. & E. HALL, LTD.,
Makers of CO_2 and NH_3
Refrigerating Machines
—and—
Hallford Motor Vehicles
10, ST. SWITHIN'S LANE, LONDON, E.C. 4.
4, Inner Temple, Dale St., Liverpool,
and DARTFORD, KENT. 8423

BRIQUETTE MACHINERY LTD
CHARMOUTH ST, LEEDS.

George Ellison
FOR ELECTRIC CONTROL GEAR

WEIGHBRIDGES
SAML DENISON & SON LTD.
FAR HUNSLET
LEEDS
London Office: 28, Victoria Street, Westminster, S.W. 1.
Telegraphic Address: "Denwatest Vic, London." Telephone: 1883 Victoria.

BUDENBERG GAUGE Co. LTD (Late Schaffer & Budenberg Ltd.)
BROADHEATH
NR. MANCHESTER.
BRANCHES: LONDON & GLASGOW.
Makers of
PRESSURE GAUGES,
Tachometers, Counters,
Dial-Thermometers,
Test Pumps, &c.
SELF-RECORDING INSTRUMENTS FOR PRESSURE, TEMPERATURE and SPEED.

ARTHUR LEE & SONS LTD
TRISAME
CROWN STEEL & WIRE MILLS, SHEFFIELD.

THIS Feed-Water Heater Is VERY EASILY CLEANED.
A GLANCE at the illustration will show the simple construction: the top being quickly removed, the tubes being straight, ensure a thorough cleaning in the shortest possible time.
Thousands of horse-power being in constant and successful use every day should be a strong inducement to write to us for particulars and prices, which will be forwarded promptly and with pleasure.
"SHORE" PATENT FEED-WATER HEATER.
T. SHORE & SONS,
Albion Foundry,
Etruria, STOKE-ON-TRENT.

PUMPS.
Direct-acting, Feed, Air & Service Pumps, Duplex & Centrifugal Pumps, Auxiliary Condensing Plant.
NICHOLS PUMP & ENGINEERING CO.,
(LATE NICHOLS BROS.), LTD.
NORTHALLERTON, YORKS. 8377

DAWSON & DOWNIE, LTD.
CLYDESBANK.
PUMPS 8316
FOR LAND AND MARINE PLANTS.
SEE ILLUSTRATED ADVT., PAGE 108, June 18.

CENTRIFUGAL
PUMPS
BON ACCORD & HIGH SPEED ENGINES
SEE OUR LARGE ADV'T IN LAST WEEK'S ISSUE.
DRYSDALE & Co LTD, TOWER, GLASGOW, W.

THE BEST 1013
MELDRUM FURNACES, STOKERS, DESTRUCTORS, SUPERHEATERS
MELDRUMS LIMITED
Canal Works, Timperley, MANCHESTER.

The Rahn-Larmon Co.,
MANUFACTURERS OF
ENGINE, TURRET and GAP
LATHES. 8340
Cincinnati, O.

CLYNE ENGINEERING CO., LTD.
Telegrams: "MONSOONIER." Tele. No. 4070 CITY.
WATER COOLERS, CONDENSING PLANTS, VACUUM PUMPS AND COMPRESSORS, STEAM TRAPS, &c. 1681
84, MARKET ST., MANCHESTER.

Contractors to the Admiralty, War Office, India Office and Crown Agents for the Colonies for every kind of
SPRINGS
SMITH BROS. & HILL, LTD. 8514
(See displayed Advt. every fourth week)
Albert Spring Works, West Bromwich

THE "STONE" SYSTEM OF HYDRAULICALLY OPERATED WATERTIGHT DOORS.
As fitted to latest Mail and Passenger Steamers.
J. STONE & CO., LTD.
Deptford, London, S.E. 8650

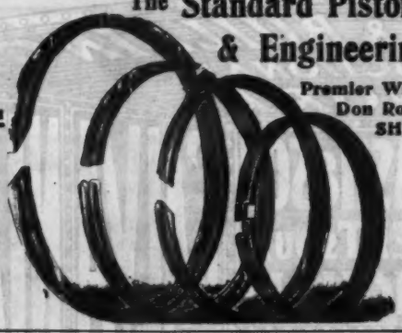
SWIFT LATHES & DRILLING MACHINES
GEORGE SWIFT & SONS LTD 8448
CLARENDON IRON WORKS
HALIFAX - ENGLAND

A. Reyrolle & Co., Ltd.
7871
Switchgear. *Hebburn-on-Tyne.*

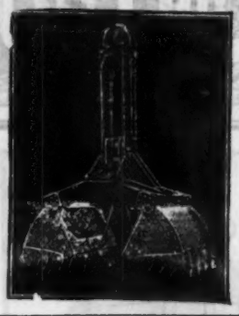
CENTRIFUGAL MACHINES.
Catalogues free on application. 8278
WATSON, LAIDLAW & CO., Ltd.,
Engineers, GLASGOW.

JOINTING MATERIAL **Permac** IN POWDER FORM
TWO THINGS THAT LIFT
A WEIGHT OFF THE MIND OF THE ENGINEER
STOPS ALL **Cling-Surface** BELT TROUBLE
THOMAS P. BISHOP, Ltd.,
37, Tabernacle Street, London, E.C. 2.

HAMMERED CAST IRON PISTON RINGS (by the Davy-Robertson Process).
All sizes from 2½ in. to 72 in.
In our Special Piston Ring Iron.
Quick Delivery. Low Prices.

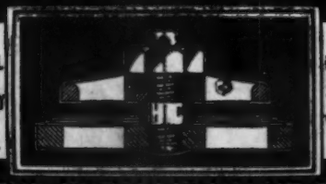


The Standard Piston Ring & Engineering Co., Ltd.,
Premier Works, Don Road, SHEFFIELD.
8238
Telephone: No. 2140.
Telegrams: Ocean, Sheffield.



HONE'S Patent SINGLE-CHAIN SPOON TYNE GRAB.
Highest Awards wherever Exhibited.
LABOUR-SAVING MACHINERY.
During the present shortage of labour, all Contractors and others handling materials, should adopt at once Hone's Patent Grabs, made in various types to suit requirements.
All particulars as to price, &c., may be obtained from the SOLE MANUFACTURERS:— 5337
JOSEPH WESTWOOD & CO., Ld,
NAPIER YARD, MILLWALL : ONDON, E.
Telephones—East 4096 (4 lines). Telegrams—Westwood, Millwall, London.

S&S
We have got
PINE
in Stock for Immediate Delivery, as follows:—
1 in., 1¼ in., and 2 in. x 7 in. and up, Best Quality, PINE SIDINGS.
3 in. x 7 in. to 11 in., Seconds, PINE DEALS.
3 in. x 7 in. to 11 in., Thirds, PINE DEALS.
1 in., 1¼ in., and 2 in., Unsorted Quality, PINE SIDINGS.
JAMES W. SOUTHERN & SON, Ltd.,
STORE STREET SAW MILLS, MANCHESTER. 7005

KINGHORN'S PATENT VALVES
THE BEST VALVE FOR PUMPS OF ALL DESCRIPTIONS ADOPTED UNIVERSALLY AND USED BY 15 ADMIRALTIES.

FITTED TO H.M.S. DREADNOUGHT & SISTER SHIPS & TO THE NEW CUNARD WHITE STAR & OTHER LEADING LINERS.
TELEPHONE 5813 CENTRAL
THE METALLIC VALVE Co COLONIAL HOUSE, WATER STREET, LIVERPOOL.
TELEGRAMS "VALVE"

THERMOMETERS
RECORDING.
0° to 1800° Fah.
ALL TYPES.
CAPILLARY TUBING,
Up to 50 yards from Source of Heat.

ENGINEERING SUPPLIES, LTD.
SUFFOLK HOUSE, 5, Laurence Pountney Hill, E.C. 4.
Telegrams: "PROELIS, LONDON." 7725 Telephone: CITY 3630

THOMAS SHANKS & Co.
Johnstone.
FOR
HEAVY MACHINE TOOLS
SEE ILLUSTRATED ADVERTISEMENT ISSUE OF JUNE 4. 7258

ENTWISLE & CASS, LD.,
Engineers, BOLTON.
For CENTRIFUGAL PUMPS, AIR COMPRESSORS, CLUTCHES, GEARING, CASTINGS up to 10 TONS, BLEACHING, DYEING & PRINTING MACHINERY. 1193

STONE AND COAL **CRUSHERS** ENG.
LEICESTER
GOODWIN BARSBY & Co

STEAM CRANES AND ELECTRIC OVERHEAD CRANES.
SAMUEL BUTLER & CO. LTD.
Grangefield Works, STANNINGLEY, near LEEDS.
'Grams—'LIFTING, STANNINGLEY." 8161
Phone—176 STANNINGLEY Private Branch Exchange.

GO TO THE
Farrar Boilerworks Ltd.,
NEWARK 8023
FOR BOILERS & RECEIVERS.
See full page advertisement other weeks.

Paterson WATER PURIFICATION SPECIALISTS 7786

BULLIVANT & CO., LD.
Steel Wire Rope Makers,
Engineers and Contractors,
BULLIVANT'S AERIAL ROPEWAYS, Ltd.,
72, MARK LANE, LONDON, E.C. 8186
Works: MILLWALL, E. Tele: 2106 Avenue (3 lines).

FOSTER BROTHERS, Limited,
TUBES & FITTINGS,
Main Steam Pipe Installations. 3048
WIDNESBURY.

J. PARKINSON & SON,
SHIPLEY, YORKSHIRE.
MANUFACTURERS OF
GEAR CUTTERS AND UNIVERSAL MILLERS

PRATCHITT BROTHERS,
PUMPING MACHINERY
BENTON IRONWORKS,
4186 CARLISLE.

Rd. White & Sons, Widnes,
FOR **RAILS,** Lancs. 7817
POINTS AND CROSSINGS.
AERIAL ROPEWAYS.

RAW HIDE GEARS
Also Metal Gears.
GEORGE ANGUS & CO., LTD.
Newcastle-on-Tyne. 8235

RAWHIDE PINIONS
. . and . .
Cast Iron Spur Wheels.
The REAY GEARWORKS, Ltd.,
GATESHEAD-ON-TYNE. 7904

LODGE
SPARKING PLUGS
FOR GAS ENGINES. 8206
See Advt. page 90, June 11.

HORDERN & MASON,
Engineers,
ST. MARY'S, BIRMINGHAM. 7915
Specialists in Sheet Metal Working Machinery.
See displayed Advt. every fourth week.

JOINTINGS.
HOUSE'S JOINTING MASTIC CEMENT FOR BOILER AND PIPE JOINTS.
HOUSE'S IRON CEMENT FOR CASTINGS.
HOUSE'S BOILER FLUID. 8669
CEMENTS IN 3 lb., 5 lb., 7 lb., and 10 lb. TINS.
68, Falkner Street, Liverpool.

LARDOLINE
THE SOLUBLE OIL
FOR ALL CLASSES OF
METAL TURNING and GRINDING.
Price 3/6 a Gallon. 8494
BRITISH OIL PRODUCTS CO., LTD.,
Townmill Road, Dennistoun, GLASGOW.

SURPLUS CLEARANCE SALE.
NEW WOODEN HUTS.

Dwellings, Bungalows, Offices, Workshops, Motor Car Houses, Pavilions, Stables, Stores, Canteens, Greenhouses, Rustic Work, Barrows, Stoves, Asbestos, and Poultry Appliances, &c. 8330
Illustrated List Post Free.
T. BATH & CO. LTD. 18 SAVOY ST. LONDON, W.C. 2.

SCIENTIFIC CONTROL
of Steam and Coal Consumption is
ACCURATELY ACCOMPLISHED
BY THE 7324
Lea Recorder Co., Ltd.
28, Deansgate, Manchester.

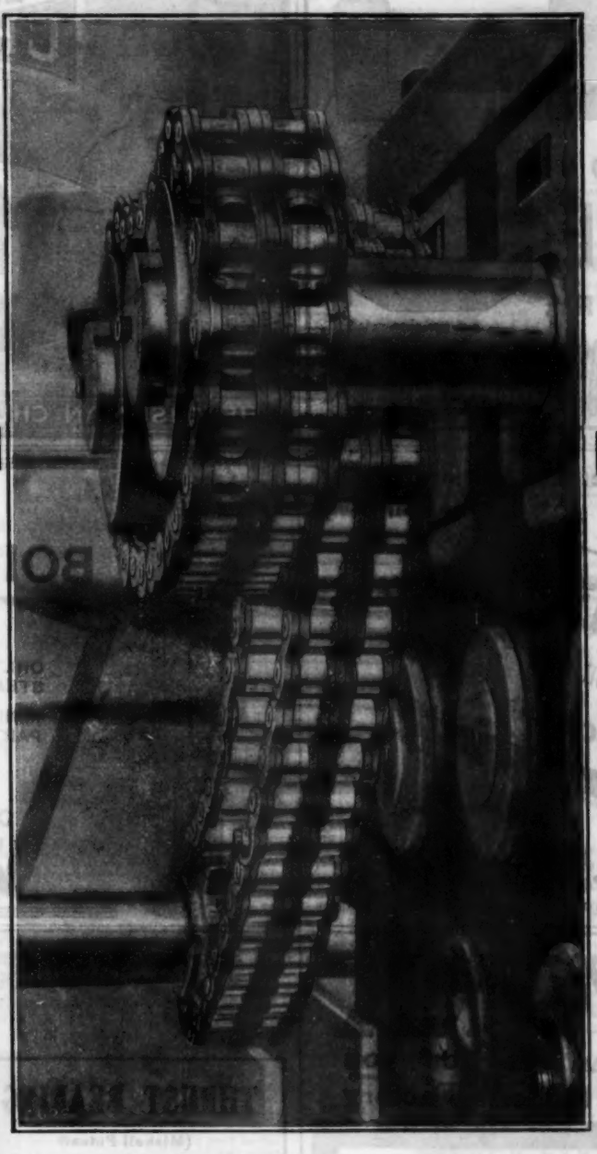
FOR **BOILERS**
LANCASHIRE & CORNISH TYPES
PRESS & GENERAL PLATE WORK
SEE LAST WEEK'S ADVERTISEMENT

FOR
WATER SOFTENERS, &c.
APPLY TO— 8085
The Harris Patent Filter (1910) Ltd.
24, Grainger Street West,
NEWCASTLE-ON-TYNE.

THERMOTANK Co.
Heating and Ventilating Engineers,
55, West Regent Street,
GLASGOW. 8022
See last and next weeks illustrated advertisement.

"BRITNIC"
— 4,000,000 HP in Service. —
WATER TUBE BOILERS and
MECHANICAL STOKERS.
(200,000 HP in Service.) 7896
The British Niclausse Boiler Co., Ltd.,
The Clock House, Arundel St., Strand, W.C. 2.

WIREWORK
FOR ALL PURPOSES.
A COUSLAND & SON
3 MITCHELL ST. GLASGOW.



HONESTY

both of workmanship and selection of material, is built into every link of "THE COVENTRY" Chains, the result being perfect service and absolute reliability under the most adverse conditions.

Our advice, which we cheerfully give, is also honest..

"THE COVENTRY" CHAIN Co., LTD.
COVENTRY - ENGLAND.
Depots:—LONDON, MANCHESTER, BIRMINGHAM 7774

BURCKHARDT ENGINEERING WORKS
Compressors & Vacuum Pumps.
26, VICTORIA ST., WESTMINSTER, S.W. 1.
Works: BASLE, SWITZERLAND. 8098
See Illustrated Advt. alternate weeks.

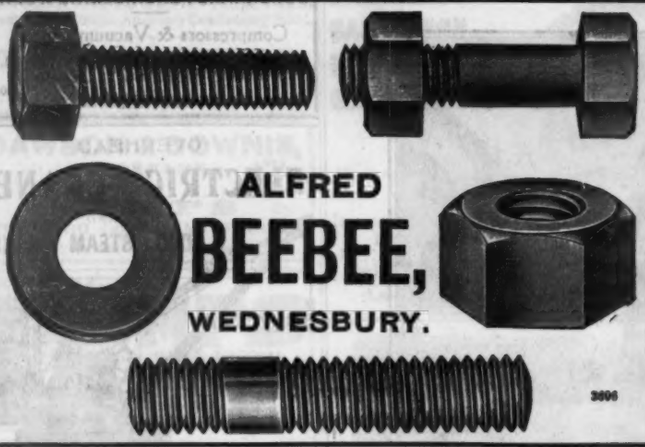
OVERHEAD
ELECTRIC CRANES
AND
LOCO. STEAM CRANES.

8168
ALEXANDER JACK & CO.,
Whitegates Eng. Works,
MOTHERWELL.

"POINTS WORTH REMEMBERING"
ABOUT
THE
"BRADFORD" WATER COOLERS 7827
HOLEHOUSE'S PATENT
¶ The best constructed cooler on the Market.
¶ No nails used for irrigation.
¶ Rails are exposed to water on all sides and exposed to free and cold air.
¶ Every cooler is made at our own works and are all standardised.
¶ They are ALL BRITISH.
THE
DAVENPORT ENGINEERING CO. Ltd.
Telegrams: "HUMIDITY." Harris Street, BRADFORD. Telephone 8553

FORGINGS IN STEEL AND IRON

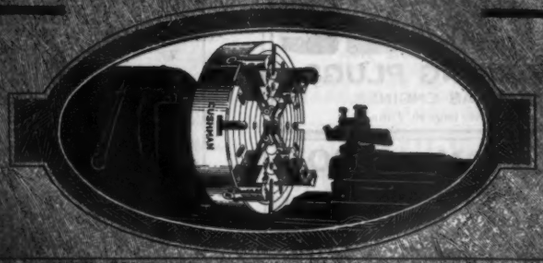
N. HINGLEY & SONS LTD.
NETHERTON IRON WORKS.
8634
DUDLEY.



ALFRED
BEEBEE,
WEDNESBURY.

3696

"CUSHMAN" CHUCKS 1862
GOOD THEN BETTER NOW



THE CUSHMAN CHUCK CO., Hartford, Conn., U.S.A.

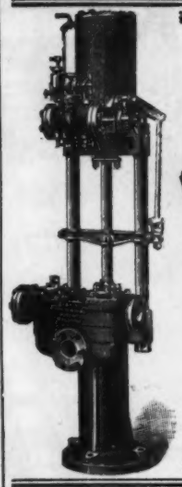
Stern Wheel Steamers. Bucket and Suction Dredgers
Tin Dredgers. of all Sizes.
Gold Dredgers.

LOBNITZ & CO., LTD.
ENGINEERS & SHIPBUILDERS,
RENFREW, SCOTLAND.

8685

Telegrams: "LOBNITZ, RENFREW."

Sole Makers of Patent Rookcutter.
For rock excavation under water without explosives.



BOILER FEED PUMPS.
ONLY ONE STEAM VALVE.
MINIMUM WORKING PARTS.
DELIVERY FROM STOCK
Up to 5000 GALS. PER HOUR.

4318

FRIEDENTHALS LTD.
RIVER ENGINE WORKS, PRESTON.

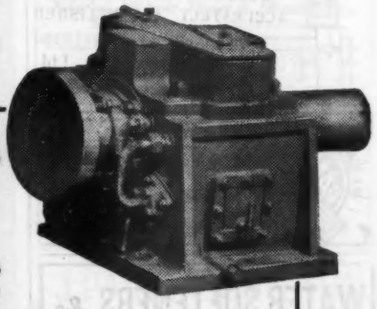
WORK
We can do for you at our Modern Factory

8189

Apply DEPT. A.

HEATH & CO LTD
New Eltham
LONDON. S.E.9

Large or Small Contracts for SMALL ENGINEERING and INSTRUMENT Work.
Components or Complete Units.
SMALL BRASS & ALUMINIUM CASTINGS.
All kinds of Experimental Work in Non-Ferreous Metals.
HARDWOOD INSTRUMENT CASES (polished or unpolished), including brass fittings if required.



THRUST BEARINGS
(Michell Patent)
SINGLE COLLAR
MARINE AND LAND TYPES
ANY LOAD AT ANY SPEED
FOR PROPELLER THRUST, TURBINES, PUMPS, WORM GEARS, ETC.
BROOM & WADE, LTD., HIGH WYCOMBE

6284

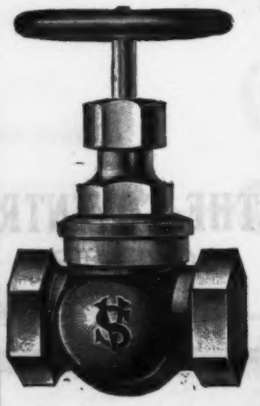
Every Kink Taken Out
On our Automatic Wire Straightening and Cutting Machine.

No matter what kind of wire you use, this machine will straighten it and cut it to accurate lengths at high speed, and it will run all day, and every day in the year.

Made in a number of sizes, lengths and styles, and equipped to suit the kind of metal to be handled.

THE CATALOGUE ON REQUEST.
F. B. Shuster Co., New Haven, Conn., U.S.A.
Formerly John Adt & Son. Established 1866.
Also Makers of Riveting Machines.

1443



IF YOU WANT RELIABLE SERVICE USE
SCOTT'S VALVES
Known by S.V. MONOGRAM cast on the body.
MADE IN TYPES TO SUIT ALL PURPOSES AND PRESSURES.
Write for descriptive catalogue to: 5095
MARKT & CO. (London), LD.,
AMERICAN MERCHANTS.
98/100, Clerkenwell Rd., LONDON, E.C.1.

BRITISH

KROMHOUT MARINE OIL ENGINES

The Ideal Power for Tugs, Barges, Coasters.

WE are now in a position to accept orders at reasonable delivery for:

4 M 5 Type 260 B.HP. 4 M 6 Type 320 B.HP

Kromhout Oil Engines.

PERMAN & Co., Ld., 82-3, FENCHURCH ST., LONDON, E.C. 3

Telephone: Avenue 5236. Telegrams: Apermaco, 'Phone, London.

AGENTS—Glasgow, DOUGLAS PRIMROSE & CO. 45, Hope Street; British Guiana, PSAILA BROTHERS, George Town, Demerara; Burma, BURN & CO. LTD. Rangoon; Calcutta, BURN & CO. LTD, Howrah Ironworks; Liverpool, S. C. CHAMBERS & CO. 3, King Street; Southampton, DAY, SUMMERS & CO. LTD. Northam Ironworks; Madras, BURN & CO. LTD.; Mauritius, TAYLOR, SMITH & CO. Port Louis; Montreal, A. J. JONES, P.O. Box 1422; Newcastle-on-Tyne, J. MACINDOE, 24, Dean Street; Newcastle (Australia), H. THURLOW & CO. Newcastle, New South Wales; New Zealand (North Island), BROWN & SONS, Te Kopuru; South-West India, DARRAGH, SMAIL & CO. LTD. Alleppey. 8877

SIZE No. 3.
Capacity in Steel 1¼ in. diam.

It's the Motor

of our own design and manufacture that gives "White-Jacoby" Portable Electric Drills their superiority.

The W-J Portable Electric Drill is Accurate, Powerful, Dependable.

We have a good stock for prompt delivery. 8389

WHITE-JACOBY & CO., Ltd.,

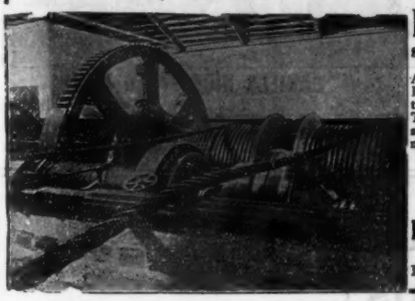
Head Office and Works:—

Bayham Place, Camden Town, LONDON, N.W. I.

Heywood & Bridge's

FRICTION CLUTCHES

IMPROVED PATENTS. 8053



IF EVERY WORKS in the country used Friction Clutches the power saved in a year would be immense.

And if the Clutches were Heywood & Bridge's they would add to the saving by their efficiency and downright good service. They run smoothly, grip firmly, and reduce shock or jar, when starting or stopping machinery, to a minimum.

100-page Catalogue (C 30) post free.

PATENTEES AND SOLE MAKERS:

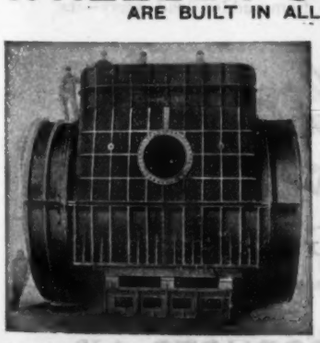
DAVID BRIDGE & Co. Ltd.

CASTLETON, MANCHESTER.

London Office: 30, Queen Victoria St., E.C.

WHEELER CONDENSERS

ARE BUILT IN ALL SIZES AND TYPES.



Wheeler Surface Condenser of 50,000 sq. ft. Tube Surface, serving a 30,000 Kw. Steam Turbine.

THE accompanying shop photograph shows a unit for a 30,000 Kw. turbine. Special attention is given to the spacing and arrangement of tubes in these condensers, so as to insure minimum pressure drop or loss of vacuum between exhaust inlet and air pump outlet.

WHEELER CONDENSER & ENGINEERING CO.

Main Office and Works—

Woodbridge Av., Carteret, New Jersey, U.S.A.

Cable Address: OBISPALIA.

Manufacturers of High Vacuum Surface Condensers High Vacuum Jet Condensers, Wheeler Tu bo Air Pumps, Wheeler-Edwards Air Pumps, Wheeler Rotative Dry Vacuum Pumps, Centrifugal Pumps, Evaporators, Forced Draft and Natural Draft Cooling Towers, Wheeler Crescent Brand Brass and Copper Tubes and Pipe, Wheeler Crescent Brand Admiralty Mixture and Munts Metal Condenser Tubes.

EUROPEAN REPRESENTATIVE:

Les Etablissements A. W. PIDWELL, 19, Boulevard Malesherbes (Paris VIII E), Paris, France. 8348

LONDON: Westinghouse Bldg, Norfolk St., Strand.

YOKOHAMA, MELBOURNE, SHANGHAI.

LLOYDS BANK LIMITED. 8896

HEAD OFFICE: 71, LOMBARD STREET, E.C. 3.

CAPITAL SUBSCRIBED	(Dec., 1919)	£58,878,400
CAPITAL PAID UP	do.	9,420,544
RESERVE FUND	do.	9,675,105
DEPOSITS, &c.	do.	325,938,436
ADVANCES, &c.	do.	135,763,591

AFFILIATED BANKS:

THE NATIONAL BANK OF SCOTLAND, LTD. THE LONDON AND RIVER PLATE BANK, LTD.

AUXILIARY:

LLOYDS AND NATIONAL PROVINCIAL FOREIGN BANK LIMITED.

"THE LANCASTER"

SUPER-LIMIT PISTON RINGS.

No loose parts.

No tongue pieces required.

Specially designed to meet the increased pressures and speeds now obtained. Illustrated leaflet on application.

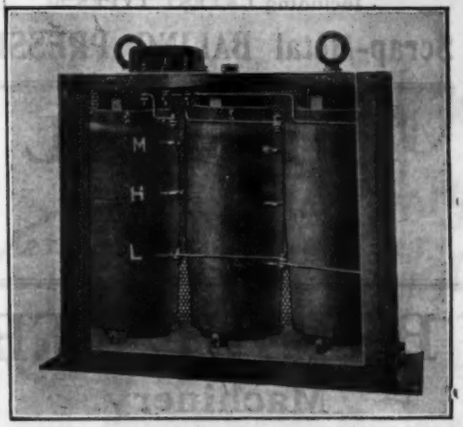
LANCASTER & TONGE, LTD.,

Sole Makers of "The Lancaster" Steam Traps, Pistons, Limit Piston Rings, Steam Dryers, Machine Moulded Wheels, &c. 8826

PENDLETON, MANCHESTER.

'EMPIRE'

AUTOMATIC CONTROL



"EMPIRE PATENT EDDYCURRENT AUTOMATIC ROTOR CONTROLLER FOR SLIPRING MOTORS.

SPECIALLY SUITED FOR LIFTS AND HOISTS ALL REVERSING MOTORS IN SHIPYARDS AND STEEL MILLS.

Branch Offices: 8500

LONDON BIRMINGHAM MANCHESTER DUBLIN NEWCASTLE SWANSEA

ELECTRIC CONTROL LIMITED

BRIDGETON, GLASGOW.

MICA

F. WIGGINS & SONS.
Telephone: Avenue 2240.
FURNACE
FOR INSULATION, SIGHT-HOLES, &c.
Largest Stock in the World OM 9234
102, 103, & 104, Minories, LONDON.

METERS
FOR
Water, Steam, Compressed Air, Gas.
GEORGE KENT Ltd., 8213
199, High Holborn, LONDON, W.C 1.
Tel.—"Kentobin, Westcent, London." Phone—Museum 4262 (5 lines).

Thomas Turton & Sons,
MANUFACTURERS OF LIMITED.
ENGINE, CARRIAGE, AND WAGON SPRINGS,
Cast Steel Files,
ENGINEERS' TOOLS, HAMMERS, EDGE TOOLS, STEEL FORGINGS, SPRING STEEL.
Tool Steel.
SHEAF WORKS, SHEFFIELD.
Od 7812
London Office: NORFOLK HOUSE, 7, Laurence Pountney Hill, E.C. 4.

HYDRAULIC
Machinery
Including LATEST TYPES of
Scrap-Metal BALING PRESSES.

OIL MILL
Machinery
for all kinds of SEEDS and NUTS.

BRIQUETTE
Machinery.

ROBERT MIDDLETON & CO.,
Sheepscar Foundry, LEEDS.
Codes Used: A.B.C., 5th Edition; MARCONI. 9008
LONDON AGENT E. C. AMOS, M.I.Mech.E., 22, Martin's Lane, Cannon St., E.C. 4.

Shortage of Coal and Labour.

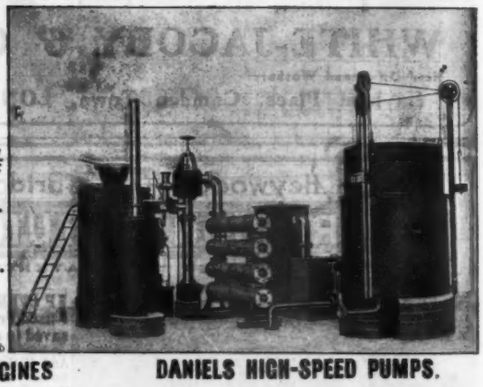
Mechanical Stokers are now a necessity.

"One of the best machines is the TRIUMPH."

TRIUMPH STOKER, LTD.,
KIRKSTALL ROAD, LEEDS. 7955

JOHN RUSSELL & Co., Ld.
WALSALL.
LAPWELDED & SOLID-DRAWN
TRADE MARK. **TUBES** 7801 TRADE MARK.
FOR LOCOMOTIVE AND OTHER BOILERS
AND
GENERAL ENGINEERING PURPOSES
ON ADMIRALTY LIST OF CONTRACTORS.

DANIELS GAS PLANTS.
PRESSURE AND SUCTION TYPES.
PATENT PRESSURE GAS PLANTS
For BLOW PIPES, STOVES, BRASS MELTING, ENGINE DRIVING, BRAZING, ENAMELLING, HEATING, &c.
10 to 20 HP. for ONE PENNY Per Hour.
Complete Pumping Installations.



DANIELS GAS ENGINES DANIELS HIGH-SPEED PUMPS.
T. H. & J DANIELS. Ld., Stroud, Eng.

Do You Pay For This?

A Film of "Foliac" Graphite on your bearings, effectively keeping the friction surfaces apart, giving cool, frictionless running, economy and freedom from sudden load worry—the actual service given by—

Foliac GRAPHITE 7137

Cup Grease

Or do you still use the old time plain grease? Write for free sample and think it over.

GRAPHITE PRODUCTS LTD.,
218/220, Queen's Road, Battersea, LONDON, S.W. 8.

A WONDERFUL CURE :—

THE DEFECT

THE EFFECT

OF THE

"BOSS" COMPOSITIONS

ALL LEAKS CURED.

The "BOSS" Jointing Compositions are the embodiment of years of research and practical experience, and every care is taken to render each production the best of its kind. Send for particulars to:—

BRITISH STEAM SPECIALTIES LTD. 7809

BEDFORD STREET,———— LEICESTER.

GRAFTON & CO.

CONTRACTORS TO H.M. GOVERNMENT,

CYCLOPS WORKS,

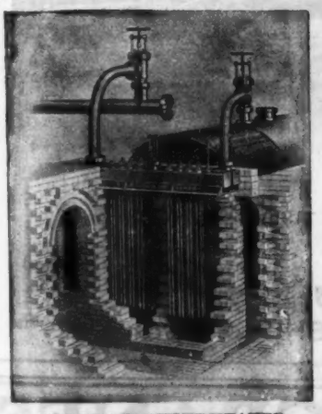
Telegrams— Grafton, Bedford. **BEDFORD.**

Illustrated Descriptive Price List free on application.

SILVER MEDAL, Inventions Exhibition London, 1885. GOLD MEDAL, Paris, 1900.
GRAND PRIX and GOLD MEDAL, Franco-British Exhibition, London, 1908.
GRAND PRIX, Buenos Aires Exhibition, 1910.

SUGDEN'S PATENT STANDARD AND SECTIONAL SUPERHEATERS

For all Types of Boilers.



STANDARD SUPERHEATER as applied to a Lancashire Boiler.

WROUGHT STEEL THROUGHOUT.

THOUSANDS IN USE.

Main advantages:—
SIMPLICITY OF DESIGN
and
READY ACCESSIBILITY to all parts.

Write for Illustrated Circular:

T. SUGDEN, Ltd.
180, FLEET STREET,
LONDON, E.C. 773

Telegrams: TUBULARITY, LONDON.
Telephone: No. 186 Holborn.

Representatives in all principal Towns.

S. SMITH & SONS, LTD.

Holders of Five Royal Warrants.

Watch and Chronometer Makers to the Admiralty and Imperial Japanese Navy.

Est. 1851.

WITH
RAILWAY SPEED RECORDING DIAL,
10/- extra.
WITH RANGE OF FIGURES for Counting Pulsations for Medical Profession ... 20/- extra.

Newest Type of Chronograph Watch.
Every Chance of Error Eliminated.
Perfection of Starting, Stopping and Fly-back Action.
7823 Absolutely Non-Magnetic.
FINEST FINISH.
17 Jewels.
Every Watch Guaranteed.

Large Selection of CHRONOGRAPHS Always in Stock from £2/2/0 upwards

Please write for Supplementary List and particulars of other Chronographs

PRICES:
9-ct. Gold Case...£21 : 0 : 0
18-ct. „ „ ...£31 : 0 : 0

PRICES:
Nic. & Oxy'd. Cases...£8 : 0 : 0
Sterling Silver Cases £10:10:0

6, GRAND HOTEL BUILDINGS, TRAFALGAR SQUARE, LONDON, W.C.

To His Majesty King George V.

By Appointment.

WAYGOOD-OTIS LIFTS

WAYGOOD-OTIS LTD. (Estab. 1833).

Offices—54-5, FETTER LANE, E.C. 4.
Tel.—Holborn 2001. Tele.—"Waygood, Fleet, London."

52-3, LIONEL STREET, BIRMINGHAM.
Tel.—Central 40 Birmingham. Tele.—"Waygood, Birmingham."

Works—FALMOUTH ROAD, LONDON, S.E. 1. 9533

"Stanlock" Regd Factory Heating

PATENTEES AND SOLE MANUFACTURERS 1542

The Standard Engineering Co Ltd
Leicester

LEROY'S Improved Patented NON-CONDUCTING COMPOSITION

REGISTERED TRADE MARK.

FOR COATING BOILERS, STEAM PIPES, &c., to prevent the radiation of heat, save fuel, and increase the power of steam. IT WILL AT ONCE SHOW a LEAK. IT CANNOT CATCH OR COMMUNICATE FIRE.

In London the cost of the Covering is saved in about six months.

May be seen where it has been in use 30 years.

ESTABLISHED 1865. 7966

F. LEROY & CO.,
20, Gray St., Commercial Rd., London, E.
Also at MANCHESTER.

JOHN OAKEY & SONS, Ltd.

GENUINE EMERY, EMERY WHEELS
EMERY CLOTH, For all Purposes.
Wellington Mills, GLASS & FLINT PAPERS.
WESTMINSTER BRIDGE ROAD,
LONDON. S.E. 1. BLACK LEAD. &c. 1906

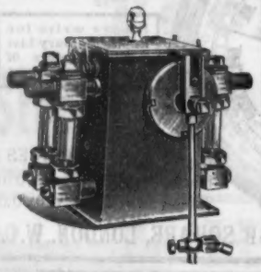
ALEX. FINDLAY & CO., Ltd.,

Steel Roof and Bridge Builders, Structural Engineers, ... MOTHERWELL, N.B.

Contractors for all the Main Buildings for the FRANCO-BRITISH EXHIBITION, LONDON, 1908, covering a total area of 560,000 square feet; also for the Grand Stadium, area 200,000 square feet.

ALL KINDS OF STEEL STRUCTURES DESIGNED AND EXECUTED.
SPECIALITY:—HYDRAULIC PRESSED STEEL TROUGH FLOORING FOR BRIDGES AND BUILDINGS

Head Office . . . . . MOTHERWELL, N.B.
London Office . . . . . 9, VICTORIA STREET, S.W.
TELEGRAMS: FINDLAY, MOTHERWELL, PARKNHUK, LONDON 9262



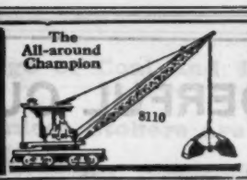
Sight Feed Lubricators

Sole Makers of 9031
Adams Patent Seafield Mechanical Lubricator and Grandison's Piston Type Lubricator.

STEAM KETTLES
for Canteens Ships, etc.

The Steam Cylinder Lubricator Co. Ld
Gordon Works, Lr. Broughton :: MANCHESTER.

BROWNING LOCOMOTIVE CRANES



The All-around Champion 8110

BROWNING
Buckets for all purposes. Send for Crane and Bucket catalogs.
The Browning Co.
Cleveland, Ohio, U. S. A.
Cable address: Brownengin.

OXYGEN FOR THE CUTTING and WELDING OF METALS.

If you are not yet making use of Oxygen for Cutting, and the Oxy-Acetylene Welding Process, or wish to hear of the latest improvements in both, write to the British Oxygen Company.

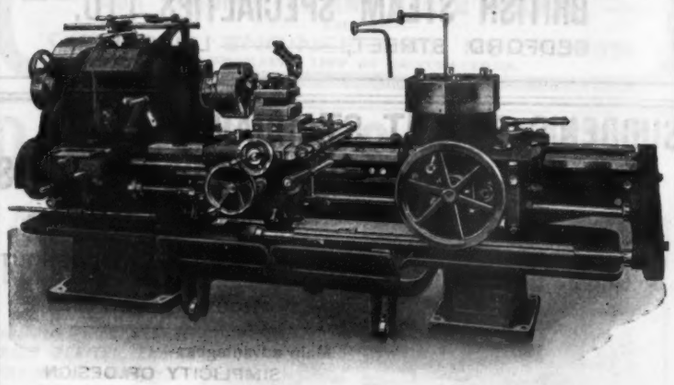
THE BRITISH OXYGEN COMPANY, the Founders of the Oxygen Industry, have highly-equipped and up-to-date factories in all the important British industrial centres capable of producing over

1,500,000 Cubic Feet of OXYGEN DAILY.

The Company are the foremost Manufacturers in Great Britain of Oxygen Metal Cutting Apparatus, Oxy-Acetylene, Oxy-Hydrogen, and Oxy-Coal Gas Welding Blowpipes, High Pressure Gas Regulators, &c.

For Catalogues and Full Particulars apply to any of the Company's Works
Elverton St., Westminster, S.W. North Wembley, Middlesex. Tunnel Av., East Greenwich. Shields Rd., Walker Gate, Newcastle. Lower Walsall St., Wolverhampton. Saltley, Birmingham. Terry Rd., Coventry. Gt. Marlborough St., Manchester. Rosehill, Polmadie, Glasgow. East Moors, Cardiff. Savile St., Sheffield. Bromborough Port, near Birkenhead. Warton Rd., Stratford, E. 7969

THE BRITISH OXYGEN CO., Ltd.,
ELVERTON STREET, WESTMINSTER, LONDON, S.W.1.



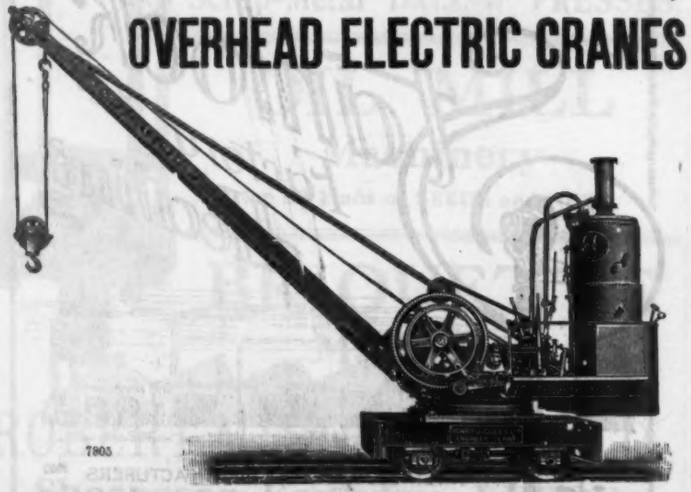
9 in. COMBINATION TURRET LATHES.

BARKER, SPINK, LEASE & Coy.

PARK WORKS, SHIPLEY, YORKS. 6130

STEAM CRANES,

OVERHEAD ELECTRIC CRANES



7805

Telephone No.: 1266 DERBY. Telegrams: "COLES, DERBY."

HENRY J. COLES, Ld., London Crane Works, Derby

CRANES

ELECTRIC, STEAM,
HYDRAULIC, HAND,

OF ALL TYPES.

WINDING AND HAULING ENGINES.

SHEERLEGS, SLIPWAYS.

TRAVELLING CRANE.

Od 6431

ALEX. CHAPLIN & CO., Ld.,

GOVAN, GLASGOW.

MAXWELL & FAGE

(Successors to BRUCE & STILL, Limited.)

49, SEFTON STREET, LIVERPOOL.

CONSTRUCTIONAL ENGINEERS and CONTRACTORS.

FOR STEEL BUILDINGS, BRIDGES, GIRDERS AND ALL DESCRIPTIONS OF STRUCTURAL WORK. TIMBER BUILDINGS DESIGNED FOR USE AT HOME AND ABROAD.

London Representative: J. W. YABSLEY, 11, Queen Victoria St., E.C. 4. Tel. 420 Central.

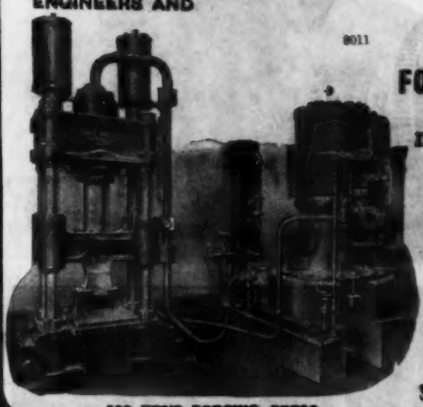
Building for Wagon Repairs. Erected by us.

Catalogues, Designs and Estimates free on application.

Telephone: No. 1817 ROYAL. 7969 Telegrams: "GALVANIZER, LIVERPOOL."

DAVY BROS. LTD
SHEFFIELD.

ENGINEERS AND BOILERMAKERS.



9011

HIGH-SPEED FORGING PRESSES with New Patent INVERTED INTENSIFIER.

The most modern forging tool in existence.

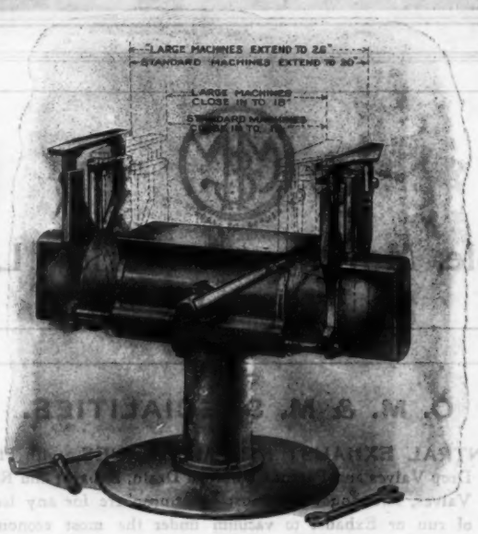
Do not instal medium and large size Steam Hammers for general forging purposes without consulting us.

ROLLING MILLS and STEEL WORKS MACHINERY

500 TONS FORGING PRESS.

Telegrams:— "Adaptable, Birmingham."
Telephone:— Midland 1968.

Codes used:— BENTLEY'S, MARCONI INTERNATIONAL.


LARGE MACHINES EXTEND TO 26"
STANDARD MACHINES EXTEND TO 20"
LARGE MACHINES CLOSE IN TO 18"
STANDARD MACHINES CLOSE IN TO 14"

ADAPTABLE MOULDING MACHINE CO.

Sydney Works, Stanhope St.

BIRMINGHAM.

MOULDING MACHINES,
CORE MACHINES,
MOULDING BOXES.
SNAPFLASKS.

8475

Pulverized Coal Equipment

AMONG some of the plants using our Pulverized Coal Equipment for heating Industrial Furnaces and Steam Boilers are the following.

AMERICAN IRON & STEEL CO., Open Hearth, Puddling and Heating Furnaces.
AMERICAN LOCOMOTIVE WORKS, Steam Boilers.
AMERICAN SMELT. & REFINING CO. Reverberatory Furnaces.
AMERICAN STEEL & WIRE CO., Open Hearth Furnaces.
AMERICAN STEEL & WIRE CO., Heating Furnaces.
ATCHISON, TOPEKA & SANTA FE R. R., Locomotives.
ATLANTIC STEEL COMPANY, Open Hearth Furnaces.
ASH GROVE LIME & PORTLAND CEMENT CO., Steam Boilers.
BETHLEHEM STEEL CO., Open Hearth Furnaces.
CHOCTAW PORTLAND CEMENT CO., Steam Boilers.
INLAND STEEL CO., Heating Furnaces.
LACKAWANNA STEEL CO., Calcining and also Flue Dust Nodulizing Kilns.
M.K. & T. RAILROAD, Steam Boilers.
MILWAUKEE ELECTRIC LIGHT & POWER CO., Steam Boilers.
NICHOLS COPPER COMPANY, Smelter.
PACIFIC COAST COAL CO., Steam Boilers.
PITTSBURG MALLEABLE IRON CO., Malleable Furnaces.
SIZER FORGE COMPANY, Heating and Forging Furnaces and Steam Boilers.
SCRANTON BOLT & NUT CO., Heating and Puddling Furnaces.
SPANISH-AMERICAN IRON CO., Ore Roasting and Nodulizing Kilns. 8189
STONE & WEBSTER CO., Steam Boilers.
UNION CARBIDE COMPANY, Lime Kilns.
UNITED VERDE EXT. MINING CO., Reverberatory Furnaces and Steam Boilers.

Practically all the Cement Plants in the United States and Canada have installations of Fuller Mills.

Some of the above plants are using Pulverized Coal containing from 10% to 17% of ash for heating their metallurgical furnaces.

Fuller Mills are to-day pulverizing over 25,000 tons of coal per day for heating various types of Furnaces.

The satisfactory performance of our pulverized Coal Equipment warrants your investigation. We manufacture Coal Crushers, Dryers, Fuller-Lehigh Pulverizer Mills, and Pulverized Coal Feeders. All this equipment is described in our Catalogue No. 71, which we will be pleased to send you.

FULLER-LEHIGH COMPANY,

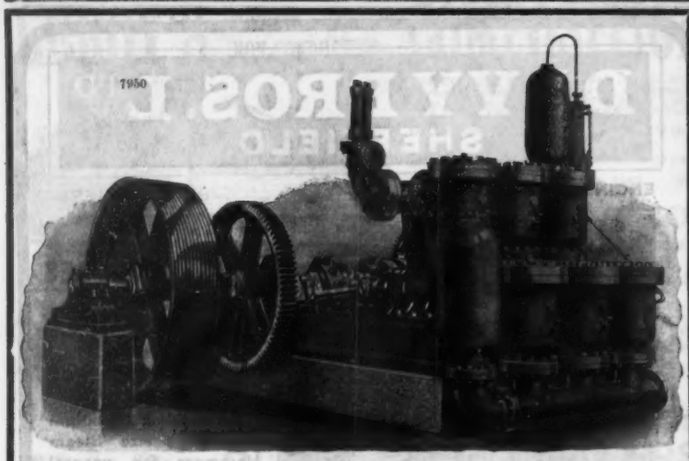
Main Office and Works - - FULLERTON, Pa., U.S.A.

BRANCH OFFICES:—NEW YORK, N.Y., U.S.A., 50, Church Street; CHICAGO, ILL., U.S.A., McCormick Buildings. PARSONS, KANSAS, U.S.A. First National Bank Building.

Special Representatives in the Iron, Steel and Copper Industries for the British Isles: WELLMAN, SEAVER & HEAD, Ltd., LONDON.

LONDON OFFICE:—25, Victoria Street, Westminster, S.W. 1.

Telephone: 4280 Victoria. European Manager: L. C. HARVEY. Telegrams: Fuslecon, 'Phone, London.

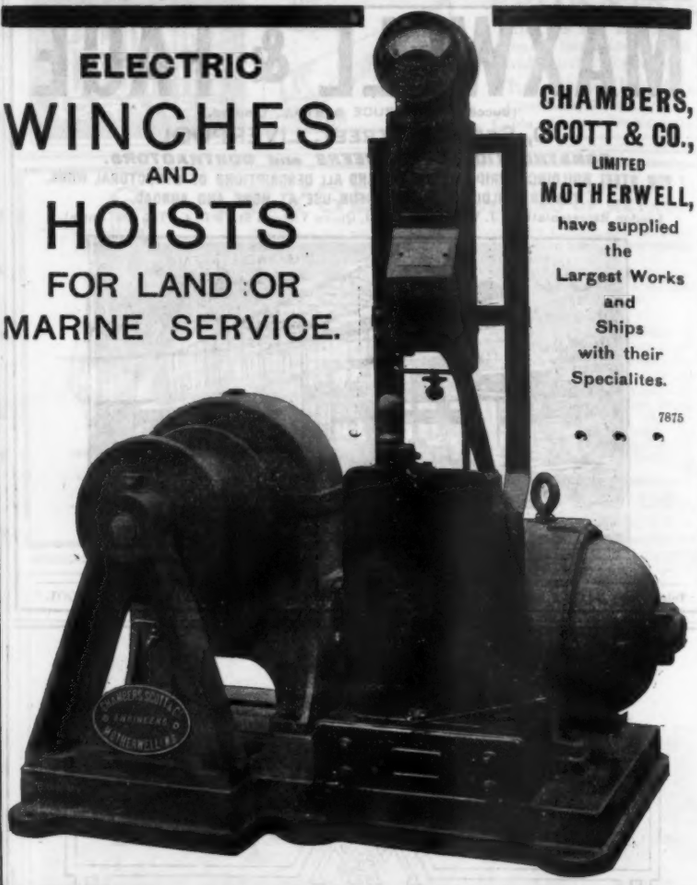


7950

ELECTRIC
WINCHES
AND
HOISTS
FOR LAND OR
MARINE SERVICE.

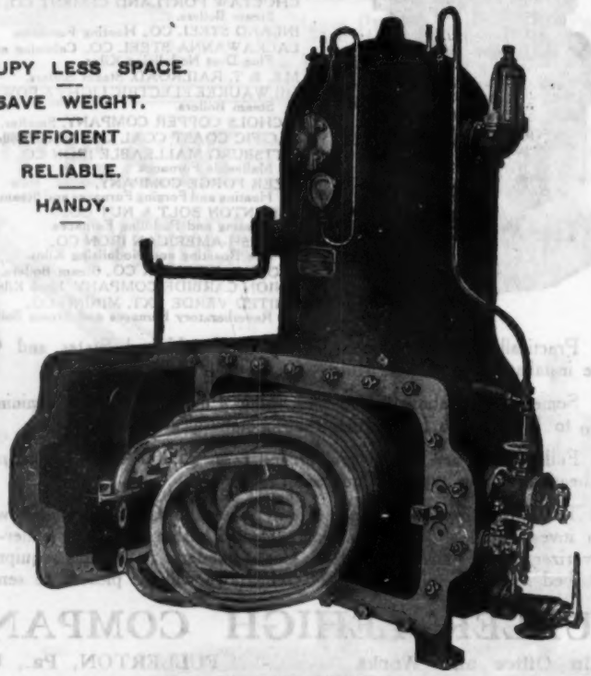
CHAMBERS, SCOTT & CO., LIMITED
MOTHERWELL,
have supplied the Largest Works and Ships with their Specialites.

7875



MORISON'S EVAPORATORS
FOR ALL CLASSES OF VESSELS.

OCCUPY LESS SPACE.
SAVE WEIGHT.
EFFICIENT
RELIABLE.
HANDY.



SOLE MANUFACTURERS:— 7909
RICHARDSONS, WESTGARTH & CO., Ltd.,
MIDDLESBRO'. HARTLEPOOL. SUNDERLAND.

Estd. C M & M 1848.
Cole, Marchent & Morley, Ltd.
Bradford, Yorks.

C. M. & M. SPECIALITIES.

CENTRAL EXHAUST STEAM ENGINES, with Piston Drop Valves and Patent Combined Drain, Exhaust and Relief Valves, allowing of Exhaust to atmosphere for any length of run or Exhaust to vacuum under the most economical conditions.

HEAT EXTRACTION STEAM ENGINES for installations where heat is required for process or other purposes in the works.

DIESEL OIL ENGINES, from 50 to 1000 B.HP. in one unit.

CONDENSING PLANTS, Surface or Jet Types, fitted with either reciprocating air pumps or steam jet air extraction.

TROMMELS for screening purposes, fitted with Lea's patent paths and rollers.

COMPLETE POWER INSTALLATIONS. 8208

We manufacture also the Spencer-Dawson Patent Power Brake, fulfilling all the Board of Trade requirements.

THOMAS PIGGOTT & Co L.D.

ATLAS WORKS,
SPRING HILL, BIRMINGHAM.

7411

BY PRODUCT PLANT FOR
BENZOL - TAR - OILS
SULPHATE OF AMMONIA.
BENZOL STILLS
TAR STILLS
PRESSED STEEL TANKS AND CONDENSERS.
TANKS FOR OIL STORAGE.
GAS HOLDERS.
RIVETTED PIPES.
WELDED PIPES
COKE CARS
COKE QUENCHERS
COKE OVEN DOORS
CAST IRON PREHEATERS
HEAT EXCHANGERS. DEPHLEGMATORS

T P & Co Ltd ATLAS WORKS BIRMINGHAM

H. & W. TRADE MARK.

HIGH-CLASS
MACHINE CUT
SPUR-GEARED
LIFTING BLOCKS

The mechanical efficiency of these blocks is very high, and every care is exercised to produce a first-class appliance. Tested to 50 per cent. overload.

HOLT & WILLETTS
LION WORKS
CRADLEY HEATH

WRITE FOR ILLUSTRATED DESCRIPTIVE CATALOGUES

6118

COAL SAVING

BY SCIENTIFIC METHODS
IN THE BOILER HOUSE.

OUR SERVICE.

WE ARE A FIRM OF TECHNICAL CHEMISTS AND ENGINEERS, WHO HAVE SPECIALISED FOR THE PAST 10 YEARS IN MODERN METHODS OF STEAM GENERATION. OUR SERVICE INCLUDES OUR OWN STAFF OF TRAINED ENGINEERS, LABORATORIES AND TESTING STATION, AND A COMPLETE EQUIPMENT OF TESTING INSTRUMENTS.

We are able to save 15-25% of the coal bill of the average boiler-plant, and we can produce the highest references from some of the best known firms in this Country for whom we have effected this saving.
WE SHALL BE PLEASED TO QUOTE YOU AN INCLUSIVE FEE FOR THE ABOVE WORK, AND MAY SAY THAT WE ARE NOT INTERESTED IN THE SALE OF ANY PARTICULAR PLANT, MACHINERY OR APPLIANCES.

WE UNDERTAKE WORK OF EVERY DESCRIPTION IN CONNECTION WITH STEAM GENERATION, SUCH AS SHORTAGE OF STEAM, SCALE, AND CORROSION TROUBLES, WATER-SOFTENING, LAGGING AND DESIGN OF STEAM-PIPE CIRCUITS, BLACK SMOKE, AMOUNT OF STEAM USED BY STEAM JETS, COAL ANALYSIS, FEED-WATER MEASUREMENTS, FLUE GAS TEMPERATURES AND ANALYSES, ETC. ALSO WE MAKE A PARTICULAR SPECIALITY OF THE DESIGN AND ERECTION OF NEW BOILER-PLANTS.

We shall be pleased to explain our proposition personally or by letter, and are prepared to visit the proposed site of any new boiler-plant **free of charge.**

Brownlie & Green, Ltd.,

TECHNICAL CHEMISTS AND ENGINEERS,
Specialists in Fuel Economy,

2, AUSTIN FRIARS, LONDON, E.C. 2.
Telephone - - - 6292 London Wall.

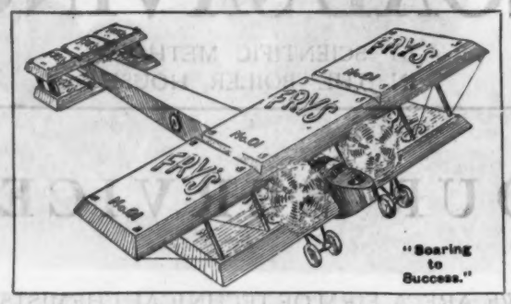
GLASGOW - - - 94, Hope Street.

LABORATORIES AND TESTING STATION,
Church Street, Cheetham, Manchester.

7266

BEARING FRY'S METALS

Standard Alloys for all purposes. Alloys to Sample or Specification.



ALLOY No. 01
for
AERO ENGINES

A Tin Alloy combining maximum toughness with great strength.

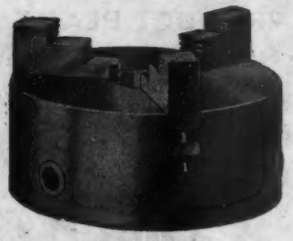
FRY'S METAL FOUNDRY

25-42, Holland Street,
BLACKFRIARS,
LONDON, S.E. 1.
Telephone No.: HOP 4730 (3 lines.)
T.A.: Frymetals, Friars, London.

Also at MANCHESTER
BRISTOL
DUBLIN
GLASGOW

8511

"GOVERNOR"
THREE-JAWED
SCROLL CHUCKS



Best Material and Accuracy guaranteed.
Parts interchangeable with Standard makes.
Supplied in 4" and 6". Three styles of Jaws.

WRITE US FOR PARTICULARS.

We invite your enquiries for any class of Machine or Small Tools.

JOHN SHAW & SONS (Wolverhampton), Ld.,
WOLVERHAMPTON.

8548

JOHN FOWLER & Co. (LEEDS) LTD.
Steam Plough Works,
LEEDS.

London Office: 113, CANNON STREET, E.C. 4.

Branches and Agencies in every part of the World.

CULTIVATING MACHINERY,
Cable Systems: Tractors: Motor Ploughs.

ROAD TRANSPORT MACHINERY
Traction Engines: Road Locos.: Wagons.

ROAD MAKING MACHINERY,
Steam Rollers: Scarifiers, Sprayers.

LICHT RAILWAY MACHINERY,
Plant, Locomotives and Rolling Stock.

8480

Ericsson Telephones

Alteration in Address

On and after 19th JUNE our London Office will be removed to 60, LINCOLN'S INN FIELDS, LONDON, W.C. 2.

To facilitate postal deliveries and avoid delays, make a note of our new address NOW.

The British L. M. Ericsson Manufacturing Co. Ltd.,
60, Lincoln's Inn Fields,
London, W.C. 2.
Factory: Beeston, Notts.

Ericsson

Led the way in 1899.
Set the Standard to-day

Sole Agent for Scotland:
MALCOLM BRINGAN,
87, Robertson Street, GLASGOW.

Ericsson

8514

HAMWORTHY
OIL ENGINES

ROYAL SHOW —STAND 218.

THE BEST IN THE WORLD.

Easily Started.

Work on Paraffin.

9 & 15 H.P. Engines, also suitable for Crude Oil.

FOR AGRICULTURAL and GENERAL PURPOSES.

Electric Lighting and Power Plants.

Prompt delivery given of any size.

PARTICULARS AND PRICES:

B.H.P.	R.P.M.	Pulley.	Flywheels.	Stationary Engine. Weight.	Stationary Engine. Price.	Portable Engine. Weight.	Portable Engine. Price.
3½	600	6" × 7"	16" × 2½"	365 lbs.	£45 0 0	510 lbs.	£55 0 0
5	600	7" × 7"	20" × 3"	590 lbs.	£60 0 0	830 lbs.	£70 0 0
9	550	10" × 10"	24" × 3½"	1,050 lbs.	£110 0 0	1,480 lbs.	£124 0 0
15	500	15" × 10"	30" × 4"	1,650 lbs	£195 0 0	2,350 lbs.	£215 0 0

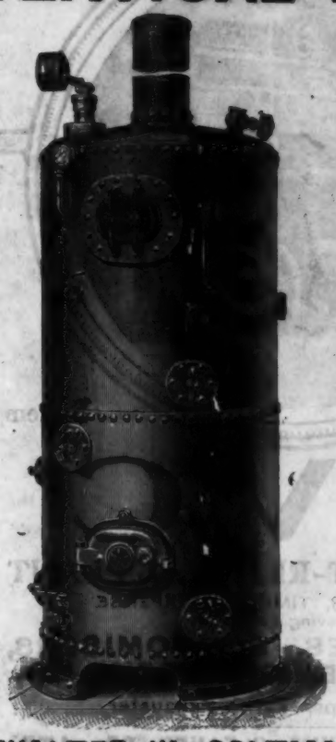
The Hamworthy Engineering Co., Ltd.,

OIL ENGINE MANUFACTURERS, 8436

76, VICTORIA STREET, LONDON, S.W. 1.

Works: POOLE, DORSET.

VERTICAL BOILERS



SPECIALTY

Vertical Cross-Tube Boilers FOR Steam Cranes.

Vertical Boilers

FOR INDIA, AUSTRALIA, AND SOUTH AFRICAN MARKETS.

ENQUIRIES SOLICITED.

Telegrams—
"BOILERS, LOUGHBOROUGH."
Telephone—
51, LOUGHBOROUGH.
Code—
A B C, 5th Edition.

WALTER W. COLTMAN & CO., LTD.,

Central Boiler Works, LOUGHBOROUGH. 7179

"MULTIPLEX" FILM EVAPORATORS

Are now in operation on

MANY REPEAT ORDERS.

GLUE, GELATINE, SIZE, COLOUR, TANNIN EXTRACTS, CAUSTIC SODA, SUGAR & GLUCOSE LIQUORS, SYRUPS, &c.,

MANY REPEAT ORDERS.

and are rapidly displacing all other types in use.

8432

SOLE MAKERS:—

BLAIR, CAMPBELL & McLEAN LTD.,

GOVAN, :: GLASGOW.

FMB FMB

STEEL FORGINGS

WELDLESS RINGS,
GEAR BLANKS,
SHAFTS,
SPINDLES,
DIE FINISHED WORK.

Supplied in the Rough, Rough Finished or Finish Machined.

ACCURATE & WELL FINISHED

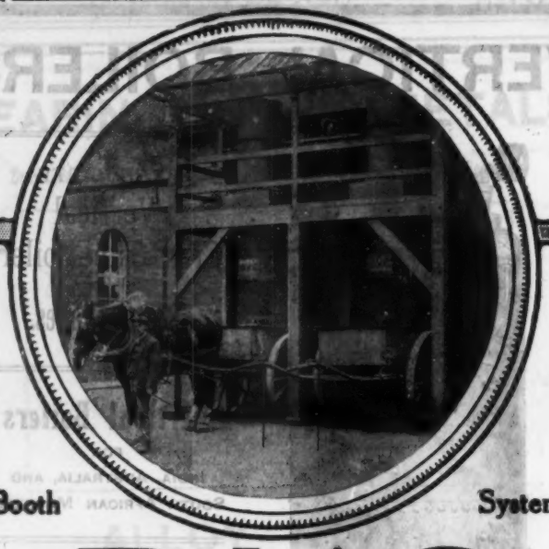
The Electro - Mechanical Brake Co., Ltd.

West Bromwich, England.

Telephones—201-202 WEST BROMWICH.
Telegrams—"BRAKES, WEST BROMWICH." 8435

London - - - DONALD H. SCOTT, 10, Arthur Street, E.C. 4.
Scotland - - - McGREGOR & CO., 74, York Street, Glasgow.
Newcastle-on-Tyne F. H. MORLEY, Star Bldgs., Northumberland Street.
Leeds - - - R. HASTE CARR, Crown Point Road.
Manchester - - L. BACKHOUSE, Cathedral House, Long Millgate.
Cardiff - - - A. N. DOUGLAS, 102, St. Mary Street.
Australia - - J. C. GILBERT LODGE, 109, Pitt Street, Sydney.

FMB FMB



Booth System

B.V.C

7838

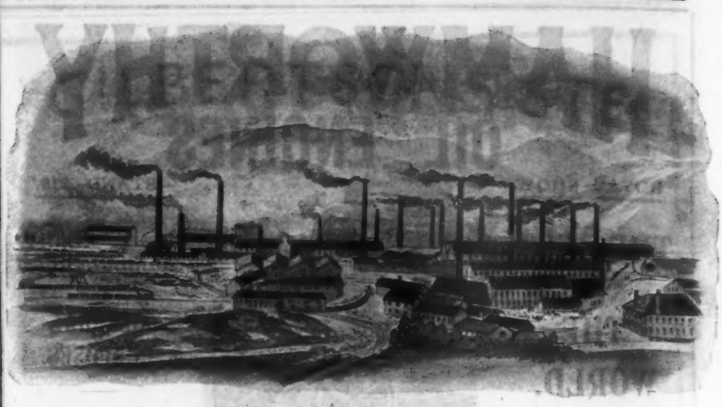
VACUUM DUST-REMOVAL PLANT

SAVES LABOUR, TIME AND EXPENSE
in removing dust from

BOILER FLUES, ECONOMISERS, FACTORIES, CHEMICAL WORKS, &c., &c.

Vacuum Pumps, Turbo-Exhauster,

THE BRITISH VACUUM CLEANER CO., LTD.,
Dept. S/20, PARSON'S GREEN LANE, S.W.



Comet No. 2.

·15% Carbon Steel

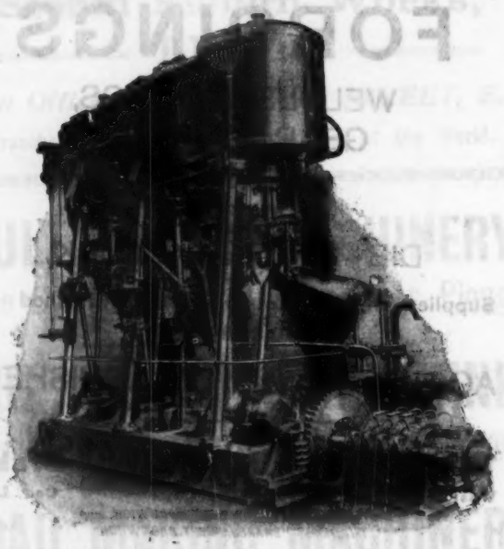
forges and machines easily and after case hardening produces a glass hard surface and tough core. Eminently suited for Cams, Camshafts, Worms, Bevel Gears, Pinions, Pins, etc. Constant and regular supplies can be arranged.

Telephone: Gerrard 4285. 8144 Wires: "Glimaximp Rand, London."

W. GILBERTSON & Co. LTD
6, LANCASTER PLACE, STRAND, LONDON, W.C.2.
WORKS, PONTARDAWE

CAMPBELL & CALDERWOOD,

Engineers and Shipbuilders,
Soho Works, PAISLEY, SCOTLAND,
CONTRACT for Vessels Complete for Shipment in Pieces or in Sections



SHIPMENT WORK A SPECIALITY—
All Types SCREW ENGINES, SIDE AND STERN WHEEL PADDLE ENGINES
Designed for Lightest Draft and Speed.
Smallest Size ENGINES up to 1500 HP.
Independent STEAM-DRIVEN CONDENSING PLANT.
Independent STEAM-DRIVEN CENTRIFUGAL PUMPS.

CATALOGUES ON APPLICATION

Telegraphic Address: Soho," Paisley. 7788
Codes: Marconi International; Engineering; A B C (5th Edition).

Alldays

7170

Sole Makers—
ALLDAYS & ONIONS, Ltd., BIRMINGHAM,
Indian Agent— (Dept. W.) and at
Alfred Herbert, CALCUTTA, Representative for India, excepting BOMBAY Presidency. 58, Holborn Viaduct, LONDON.

FLUXES BLOWPIPES WELDING-WIRES and ACCESSORIES FOR OXY-ACETYLENE WELDING & CUTTING

A-L TRADE MARK

MANUFACTURED FOR ALL THE LEADING ENGINEERING FIRMS THE WORLD OVER.

ALLEN-LIVERSIDGE LTD

HEAD OFFICE—106 VICTORIA S^T WESTMINSTER S.W.1

ON ADMIRALTY, WAR OFFICE AND INDIA OFFICE LISTS.

The Metallurgical Co. Ltd.

82, VICTORIA STREET, Westminster, London, S.W.

Works:

Walker Gate, Newcastle-on-Tyne

London Telegrams:
"Liatemingo," Vic., London.
Telephones:
1928 & 1929 Victoria, London.
Works Telegrams:
"Ingots," Newcastle-on-Tyne.
Telephones:
3551 & 3552 Central, Newcastle-on-Tyne.

MAKERS OF HIGH-CLASS ALLOYS IN INGOTS TO GOVERNMENT, RAILWAY, OR ANY OTHER SPECIFICATION.

GUNMETAL & PHOSPHOR BRONZE INGOTS
Guaranteed to Admiralty and War Office Specifications, or any other specified mixture.

MANGANESE BRONZE INGOTS
to War Office and Admiralty Specifications, and special K. V. B. qua ity, testing 40 tons Tensile, 20 tons Yield and 20-24% Elongation.

SPECIAL BRASS INGOTS 8391
A. B. C. & G. qualities to War Office Specifications.

MANGANESE COPPER, FERRO ZINC, NAVAL BRASS,
Babbitt and White Metal Ingots of every description.

ORDINARY YELLOW BRASS AND GUN METAL INGOTS
for Commercial Work.

BEST SELECTED COPPER INGOTS, "M.C.L." BRAND.

"Consolidated" Safety Valves

for Small and Portable Boilers

are characterized by a relieving capacity in excess of that found in other safety valves, and will positively prevent the pressure rising above that at which the valve opens.

Consolidated Safety Valves are made of bronze with a handsome finish, and each carries a plate on which are plainly stamped the popping pressure, the lift, the closing pressure, and the pounds of steam which the valve will relieve per hour.

Our agents, listed below, carry these valves in stock, in all sizes, set at 100 and 125 pounds; they are prepared to advise you regarding selection of the proper size and to make quick deliveries.

Consult them also regarding Ashcroft Gauges and Metropolitan Injectors, used for years by engineers all over the Continent. All graduations and connections in British Standards.

MANNING, MAXWELL & MOORE, Inc.,

NEW YORK.

REPRESENTATIVES: 8467

ENGLAND. CRANE-BENNETT, LTD., 45/51, LEMAN ST., LONDON, E.1.

SCOTLAND. PHILIP & BRUCE, LTD., GLASGOW.

France. MARKT & Co. (Paris), Ltd., 107, Avenue Parmentier, Paris.

Belgium A. A. KAMPRATH (Brussels), 88, Rue de la Caserne, [Ltd., Bruxelles.

Italy. MARKT & Co. (Milan), Ltd., Via Alcardo-Alcardi 2, Milan.

MMM-34A

Quality & Price

Two Essentials for
:: :: Engineers :: ::

PIPE FITTINGS.
Malleable and Cast Iron,
Wrought Iron and Gun Metal
Hangers and Brackets.

VALVES & COCKS.
Iron or Gun Metal, Screwed & Flanged.

TOOLS.
Walworth and Hart's Diestocks,
Wrenches, Pipe Cutters, Vices, etc., etc.

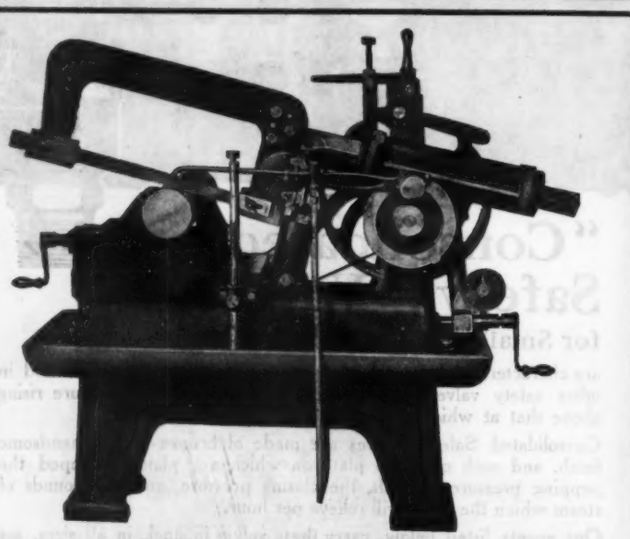
Catalogue (illustrated) on application. 8511

H. MUNZING, Limited,

(DEPT. E.G.)

90-96, Union St.
LONDON, S.E.1.

he largest Battery
of Wooden Cooling
Towers installed
in this Country.
We illustrate the Water Cooling Plant at Willesden which we installed for the L. & N.-W. Railway. To our knowledge no other Wooden Cooling Tower installation in Britain has an equal capacity of gallons per hour. But although this plant creates a record in our history, we can point to many other installations which for magnitude stand out as landmarks in this field of engineering.
We are prepared to guarantee the results from any plant supplied by us.
The PREMIER COOLER & ENGINEERING CO., Ld.
Station Works,
SHALFORD,
near
Guildford, SURREY.
Telegrams:
"Precooler, Shalford."
Telephone
Shalford 27
8411



RAPID SAWING MACHINES

with dashpot relief on back stroke
and automatic stopping mechanism.

CAPACITIES: 6 in. by 6 in. to 26 in. by 26 in.

PROMPT DELIVERY.

EDWARD G. HERBERT, LIMITED,
CHAPEL STREET LEVENSHULME,
MANCHESTER.
6970

THE
VICTORIA MIXER.

PLANTS SPECIALLY DESIGNED AND CONSTRUCTED FOR DOCK WORK.

THE VICTORIA MIXER DEALS SUCCESSFULLY WITH
CONCRETE, ORES,
GLASS BATCH, FERTILISERS.
8601

Mixers in Stock Ready for Immediate Delivery.

Full Particulars from

STOTHERT & PITT, Ltd.,
38, VICTORIA STREET,
LONDON S.W. 1.

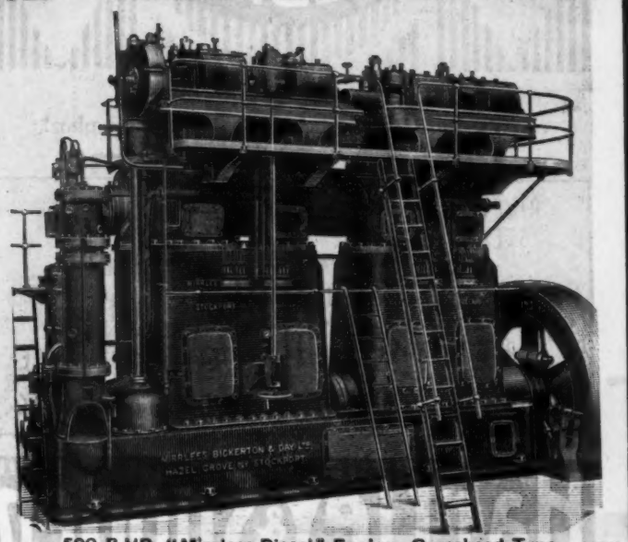
MIRRLEES, BICKERTON & DAY, LTD.,

Hazel Grove, near STOCKPORT.

LONDON Office { 122, Cannon Street, E.C. } Telegraphic Address { "ECONOMY, HAZEL GROVE." }

MAKERS OF

The "MIRRLEES-DIESEL" OIL ENGINE.



500 B.HP. "Mirrlees-Diesel" Engine—Crosshead Type. 8007

THE MOST ECONOMICAL ENGINE MADE

FOR LIGHTING, TRACTION, POWER, PUMPING, PROPULSION, &c.

CHEAP AND SAFE OILS USED AS FUEL.

Cradley Cross Tube Boilers

in

STOCK

and

PROGRESS

For LAND and MARINE USE.

8005

CRADLEY BOILER CO., LTD.,

CRADLEY HEATH, STAFFS.

Well-founded

Edgar Allen Steel Castings have a well-founded reputation for soundness and reliability. They have earned it by being carefully supervised before dispatch. Uniformity of composition is proved by their good mechanical tests. For instance, an average test on steel castings for locomotive work shows a tensile strength of 30 tons per square inch, with an elongation of 30%, in 2 inches and a bend of 180°.

Edgar Allen's

Toughened Steel Castings

from one pound to ten tons in weight can be made in the Edgar Allen Steel Foundry, and in a single week as many as 8077, aggregating 290 tons have been produced. Write for Catalogue G.

To EDGAR ALLEN & CO., Ltd., Imperial Steel Works, Sheffield.

Please post "Drill Data" to

Name.....

Firm.....

Address.....

.....

E.

8485

HAYWARD-TYLER & Co LD

PUMPS & PUMPING MACHINERY.

VERTICAL THREE-THROW PLUNGER PUMP

For Driving by OIL ENGINE.

Duty 42,000 Gallons of Water per hour.

PUMPS SUITABLE FOR ALL PURPOSES.

WRITE FOR CATALOGUES.

8613

HEAD OFFICE: Works: LUTON, BEDS.

99, QUEEN VICTORIA STREET, LONDON, E.C.4.

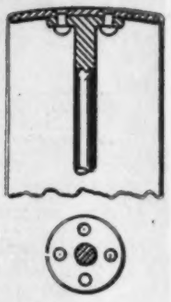
PATENT . . Satisfaction already given on exceptionally severe Drives and Repeat Orders received.

"Stanchion"

Wrought Iron . . **Pulleys** (Patent No. 20019).

Designed for Heavy Drives, High-speeds, and where Vibration or Shocks are present.

Arm Heads machined accurately to curve of Rim.



Palmed Arm Heads, forged from the solid Bar—not screwed on.

Quotations and full particulars on application.

PATENTEES AND SOLE MANUFACTURERS—

DOUGLAS, LAWSON & CO.,

Engineers, ***BIRSTALL,*** *LEEDS.*

Telegrams: PULLEYS, BIRSTALL. Telephone: 135, BATLEY. Code used: A B C 5th Edition.

On LISTS of ADMIRALTY, WAR OFFICE, INDIA OFFICE and CROWN AGENTS FOR THE COLONIES. 7630

ELECTRIC ACETYLENE & FIRE **WELDING** WELDING EXPERTS

50 Years' Experience applied to up-to-date methods and plant

RIVETED VERTICAL STEAM BOILERS
MILD STEEL PRESSINGS
AIR RECEIVERS
H.P. CYLINDERS ETC.

CONTRACTORS TO THE ADMIRALTY WAR OFFICE COLONIAL OFFICE HOME OFFICE ETC.

Hartley & Sugden Ltd.

HALIFAX. ENGLAND

LONDON OFFICE ... GREAT PORTLAND ST. W.1

8570

BRICO PISTON RINGS

These Piston Rings are manufactured on the most advanced principles known to-day. The experience of aircraft requirements during the war is embodied in both design and material.

We claim that BRICO Piston Rings are as near perfection as any piston ring in the world.

Even in appearance alone BRICO Piston Rings proclaim "quality" and a practical test of the rings in an engine will prove that their performance is equal to their appearance.

Perfect in finish, in fit, and in material, BRICO Piston Rings increase engine power and save lubricating oil.

BRICO Piston Rings are made for all popular motor car and motor cycle engines as well as for steam and gas engines, pumps, etc., compressors, etc. Large stocks of the standard sizes are ready for immediate delivery.

Write for new Price List E.

THE BRITISH PISTON RING CO., Ltd.,
HOLBROOK LANE,
COVENTRY.

Telegrams— *Pistorings, Coventry.* 7775 *Telephone—* 1214—1215.

EVERITT & CO. LIMITED

40, CHAPEL STREET,
Telegrams: "PERSISTENT."
Telephone: 1134 CENTRAL (3 lines). LIVERPOOL.

FERRO-ALLOYS & METALS.

FERRO-TUNGSTEN, 75/80% and 1% Carbon max. 80/85% and 0·1% Carbon max.
TUNGSTEN METAL POWDER. 98/99%
FERRO-VANADIUM. COBALT METAL.

PHOSPHOR TIN	FERRO-BORON	CADMIUM METAL
PHOSPHOR COPPER	FERRO-URANIUM	ANTIMONY
FERRO-TITANIUM	FERRO-TANTALUM	NICKEL
FERRO-PHOSPHORUS TIN	FERRO-ZIRCONIUM COPPER	ZINC SILICON-COPPER

— SPIEGELEISEN —

FERRO-CHROME. 0·5%, 2%, 4/6%, 6/8%, 8/10% Carbon. | **FERRO-SILICON.** 9/13%, 25%, 45/50%, 75%, 80/85%, 90%

ALUMINIUM (Notched Bars, Half-round Sticks, Granules, and Powder).

FERRO-MOLYBDENUM. MAGNESIUM METAL.
SILICON-MANGANESE.
MANGANESE METAL. CHROMIUM METAL. (Carbon free)

8171

MINERALS:
MANGANESE, CHROME, WOLFRAM, SCHEELITE, MOLYBDENITE, FLUORSPAR, MAGNESITE, KIESELGUHR, ASBESTOS, GRAPHITE, ANNEALING IRON ORE, PIG IRON, &c., &c.

Stop Waste!

All the time spent on machining and hand finishing most small parts is time wasted. 50 to 80 per cent. of the cost is money wasted. Because our perfected method of

DIE CASTING

will save you all that time and all that money while giving you parts superior in accuracy and of guaranteed quality. Consult us in confidence. Stop this waste. Increase your output ***and profits.***

8309

The Patent Die-Castings Co., Ltd.,
64, Stiode Road, Willesden Green, London, N.W.10.
TELEPHONE: WILLESDEN 732.

MONEL METAL

¶ Unaffected by moisture, salt water and alkalies. Superior to steel and bronzes in retaining strength at high temperatures.

¶ Now extensively used with great success for fittings in contact with superheated steam of temperature up to 750° Fahr., also for valves, rods, and shafts of pumps working with corrosive water.

¶ Supplied in Rods, Bar, Sheet, Forgings, Stampings, Castings, Wire, Woven Wire, Strip, Turbine Blading, etc. Can be cast, forged and easily machined.

Booklet on Application.

G. & J. WEIR, Ltd., MONEL DEPT.,
CATHCART, GLASGOW.

7589

Made Specially for every type of Lathe

There is no guesswork about Super-Screwol. It is tested before it leaves our works, and because it is such a splendid oil we offer to send you a barrel on approval.

SO many claims are made now-a-days as to the virtue of any particular product that in proclaiming Super-Screwol to be an oil of *superlative* value for cutting purposes we may be accused of over-enthusiasm.

So let us tell you about Super-Screwol and the conditions under which it is made.

Super-Screwol, like all other Sternol Oils and Greases, is made at our London Factory. Highly technical managers — men who are Engineers themselves and know exactly the requirements of a cutting oil—supervise every stage of the production. Analytical Chemists test every complete "making," and before it is passed, Super-Screwol must attain a standard very much higher than it will ever be called upon to reach in any shop.

Super-Screwol is a soluble oil which does not rust, clog or separate. It prolongs the life of the tool; it is antiseptic to Government standard; it is always uniform in quality, and it is economical in use. It is used in preference to other oils by the largest engineering concerns in the country, and so great is our confidence in its superlative quality that we are prepared to send you a barrel on approval. If it should prove unsatisfactory in use, send it back: no charge will be made for the quantity used, neither will you be charged for carriage. Could any firm show greater confidence in its product?

STERNS LTD.

Makers of Oils and Greases for every particular lubricating requirement.

8198

A.D. 56, ROYAL LONDON HOUSE, FINSBURY SQUARE, E.C.

Telegraphic Address: Centumvir, 'Phone, London." *Telephone: 1875 Clerkenwell (3 lines).*

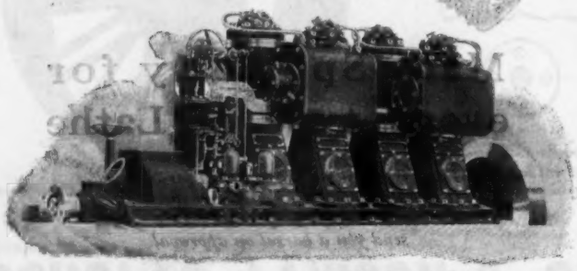
The discriminating buyer must consider the PLENTY True Semi Diesel Marine Oil Engine, because

30 B.HP. to 300 B.HP.

Its many special mechanical features are unique and of proven value, the design is based on our experience of Marine Engine requirements over the last 50 years, their value cannot be excelled or their quality equalled.

Every standard Engine is built up to or over Lloyd's requirements, and every Engine of 50 HP. or over has the main forgings surveyed by Lloyds at our expense.

Our new 24-page Illustrated Catalogue will give you full particulars of these remarkable Engines.

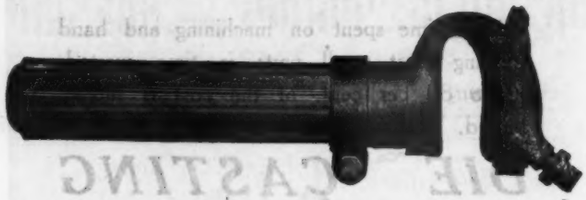


8032

PLENTY & SON, LIMITED,
KINGS ROAD WORKS,
NEWBURY, ENGLAND.

Telephone— 7 NEWBURY.
Telegrams— PLENTY, NEWBURY.

The "JOHN BULL" PNEUMATIC TOOLS



ALL SIZES OF PNEUMATIC, RIVETING, CHIPPING AND CAULKING HAMMERS AND HOLDERS - ON

IN STOCK

8371

THE HOWARD ESTABLISHED 1904 — PNEUMATIC ENGINEERING CO. LTD. EASTBOURNE.

75% SAVING!

What a PRIESTMAN GRAB did for a large Dock Co.

"Dear Sirs,
.... We have pleasure in expressing our appreciation of the GRAB obtained from you which has been of great use in connection with the working of our Ore Traffic. We find that over a period our cost of working with the GRAB is roughly a **reduction of 75%** *as compared with the cost of working with pans .....*
Yours faithfully,
....."

We may be able to do the same for you. Will you allow us to study your material handling conditions, and make suggestions?

7884

PRIESTMAN BROTHERS, LTD.
HOLDERNESS FOUNDRY, HULL,
And at
LONDON, CARDIFF, GLASGOW, MIDDLESBROUGH.

"CROOMS HILL" AND "PERNAX"

Electric Wires and Cables

FOR ALL
POWER, LIGHTING, TRACTION, TELEGRAPH, TELEPHONE AND SIGNALLING PURPOSES.

Specially adapted for outside and exposed positions.
Insulation; Non-porous, Non-brittle and Waterproof.

Makers—
The New Gutta Percha Co., Ltd.
:: :: DASHWOOD HOUSE :: ::
NEW BROAD STREET, E.C. 2.

Works: CROOMS HILL, GREENWICH.
Branches: Newcastle-on-Tyne. Manchester. Birmingham. Glasgow.

8383

For compressing Air or Gas

for industrial purposes, such as for Furnace Heating, Metal Melting, Brazing, Soldering Bits, Laundry Irons and Machines, etc., you cannot do better than instal

KEITH
ROTARY COMPRESSORS

For pressures up to 5 lbs. per sq. inch and volumes up to 50,000 c. ft. per hour, and arranged for any drive.

WRITE FOR CATALOGUE 8.

JAMES KEITH & BLACKMAN CO., LTD.,
27, FARRINGDON AVENUE, LONDON, E.C. 4.

8273

Hartness
Flat Turret Lathe

The single spindle Flat Turret Lathe for chuck and bar work; the double spindle machine for chuck work only.

: QUICK :
DELIVERY

May we have your orders now?

8880

JONES & LAMSON MACHINE CO.,
109, Queen Victoria Street,
LONDON, E.C. 4.

Telephone—722 City. Telegrams—Turretorum, Cent.

"CAMEL HAIR"
(REGISTERED TRADE MARK)
BELTING

UPWARDS OF 90,000,000 FEET SUPPLIED TO WORLD WIDE USERS.

CEMENT WORKS
TUBE MILL MOTOR DRIVE.

THE

HAS AN UNBLEMISHED REPUTATION OF NEARLY 46 YEARS, AND IS THE MOST SUCCESSFUL AND RELIABLE BELT IN THE WORLD.

Sole Makers:

F. REDDAWAY & CO., LIMITED,
PENDLETON, MANCHESTER.

7326

LONDON:
30-51, LIME STREET, E.C.

SIMPLEX PETROL, BENZOL OR PARAFFIN SHUNTING LOCOS.

Thoroughly efficient and reliable.

They are built to stand up to the hardest work and have many advantages over Steam Locomotives.

Locos for all gauges.

40 B.HP. Simplex Petrol Shunting Locomotive.

Cheap to run and inexpensive to maintain.

Estimates on request. Please write, giving gauge, gradients and gross loads to be hauled.

We can give prompt deliveries.

8613

THE MOTOR RAIL & TRAM CAR CO., LTD., Simplex Works, BEDFORD

Aldrich Pumps

WITH MOTOR ON TOP.

Cut illustrates a 9 in. by 12 in. Vertical Triplex having the added feature of its "motor on top" out of flooding danger and reducing floor space. Capacity 500 U.S.G.P.M. against 600 feet head. Can be fitted with cement lined, bronze fitted water-end for acidulous water. An ideal mine pump. :: :: Write for "Pump Data" listing standard sizes.

THE ALDRICH PUMP COMPANY, 8145
Allentown, Pa., U.S.A.

British Agents: GILLESPIE & CO., Leadenhall Buildings, 2, Whittington Avenue.

STEAM TRAPS

of one kind or another crowd the market. We aim to supply one unique in the certainty of its action and the capacity of its discharge. It is mechanically operated. Discharge Valve either full open or dead closed. Sent on approval anywhere. 7617

The UNITED STATES METALLIC PACKING CO., Ltd.

Telegrams—"METALLIC, BRADFORD." Soho Works, Allerton Road, BRADFORD. Telephones—4705 and 4706.

LONDON—110, Fenchurch Street.
GLASGOW—52, St Enoch Square.
NEWCASTLE-ON-TYNE—2, Collingwood Street.
LIVERPOOL—15, Fenwick Street.
BOLTON—15, Mawdsley Street.
SHEFFIELD—24, Norfolk Row.
SWANSEA—Angel Chambers, York Street.

W. G. BAGNALL, LTD., STAFFORD, ENGLAND.

MAKERS OF
Sugar Cane Wagons,
Tipping Trucks,
Turntables,
Switches, &c.

BUILDERS OF LOCOMOTIVES
weighing from 3 to 50 tons, for any gauge, of highest-class workmanship and material, at competitive prices.

Od 681

HOISTING & TRANSPORTING MACHINERY

CRANES.
AERIAL CABLEWAYS.
WINDING ENGINES.

ABERDEEN—
KING'S WORKS.
Telegrams—"Cranes, Aberdeen."
Telephone Central 3162 (3 lines).

ON ALL PRINCIPAL LISTS.

ELECTRIC STEEL CASTINGS

FOR ALL PURPOSES
TO ANY SPECIFICATION

UP TO **3 TONS** IN WEIGHT

TELPHERS.
AERIAL ROPEWAYS.
TRANSPORTERS. 8180

LONDON
17, COCKSPUR ST., S.W. 1.
Telegrams—"Needreba, Westrand, London."
Telephone—Gerrard, 9963.

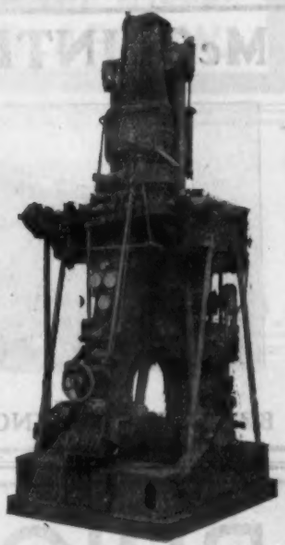
JOHN M. HENDERSON & CO., ABERDEEN

DOXFORD OPPOSED PISTON TWO-STROKE MARINE OIL ENGINE.

Perfect Combustion with Crude Oils. Solid Injection.

"SUPERHEAT" OIL FUEL INSTALLATIONS FOR STEAMERS.

Shipbuilders. Engineers.



WILLIAM DOXFORD & SONS, Limited.

SUNDERLAND.

Tel. Address: "DOXFORD, SUNDERLAND." Tel. Nos.: 412, 413, 414, 1141.

8403 CAN BE SEEN BY APPOINTMENT. This Demonstration unit has made a continuous run of Five Weeks at 650 HP. under supervision by Lloyd's. Bore 10½ 110 Revs.

THE "SELSON"
HIGH SPEED AND HEAVY-CUT
SHAPING MACHINES

POINTS.

Ram adjustment by hand wheel, rack and pinion. Locking lever for same on same centre as hand wheel.

Draw stroke to ram, giving smooth even cutting motion.

All adjustments of ram and stroke can be made **before starting.**

Stroke also adjustable whilst machine is running.

Feed can be altered or reversed **without stopping** the machine.

25 in. stroke (*as illustrated*), **in stock.**

OTHER SIZES:
10 in. & 13 in. Stroke, cone pulley drive. 17 in. & 30 in. Stroke, single pulley drive.

SELSON
Engg. Co., Ltd.

SELSON HOUSE, 83 & 85, Queen Victoria Street, LONDON, E.C. 4. Works: COVENTRY.

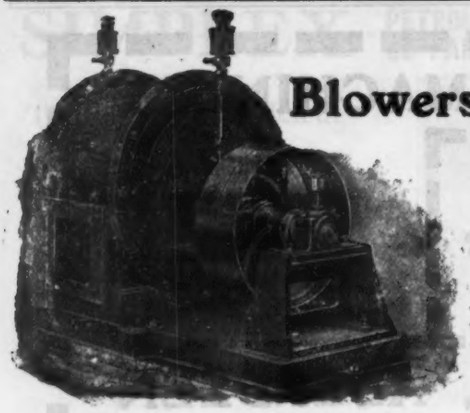


Fig. 550.

DONKIN

Blowers, Gas Compressors, Exhausters OF THE Positive Type

For INDUSTRIAL PURPOSES.

For Gas Works, for Chemical, White Lead, Soap & Oil Works, for Pumping Gas, Forcing Air through Liquor, &c., for Agitating or Mixing, &c.

Can be arranged for driving by Belt, Steam Engine, Gas Engine, or Electric Motor.

ADVANTAGES AND FEATURES:

Absence of all Valves.
Simplicity of construction and small number of working parts.
Working parts entirely enclosed.
Good efficiency. Silent working. 8274

THE BRYAN DONKIN CO., LTD.,

Engineers, CHESTERFIELD, ENGLAND.

McCLINTIC-MARSHALL PRODUCTS COMPANY

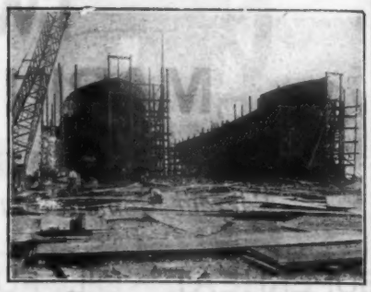
ENGINEERS AND MANUFACTURERS.

STEEL CONSTRUCTION

ANNUAL CAPACITY 400,000 TONS.

McClintic-Marshall Products Co.
Riter-Conley Manufacturing Co.
Union Shipbuilding Co. 8679

Write for Catalogue S,
50, Church Street, New York, U. S. A.
Cable: MACMARSH, New York.



BRIDGES—BUILDINGS—RIVETED PIPE—STORAGE TANKS—TRANSMISSION TOWERS—SHIPS

BRIGHT

COLD ROLLED FOR ALL PURPOSES.

DRAWN HEXAGON & ROUND

STEEL

BRITISH ROLLING MILLS, LIMITED,

Cleveland Street,

BIRMINGHAM. 8390

TELEgrams—"OCTAGON."
Phone—Central 1869. 1870.

ARMSTRONGS & MAIN, LTD.

Sir W. G. Armstrong Whitworth & Co., Ltd. (Engine Works), and A. & J. Main & Co., Ltd.

GENERAL & CONSTRUCTIONAL ENGINEERS.

ELECTRIC & HYDRAULIC CRANES, CAPSTANS PUMPS, HAULAGE GEARS, AIR COMPRESSORS, STEEL BUILDINGS, ROOFS, BRIDGES, DOCK GATES.

CLYDESDALE AND GERMISTON WORKS, GLASGOW.
CALCUTTA BRIDGE & ROOF WORKS, CALCUTTA.

LONDON OFFICE:
Australia House,
Strand, W.C. 2.

GLASGOW OFFICE:
149, West George Street. 6675

TUBES LIMITED

WELDLESS TUBES for BOILERS and STEAM PIPES
LOCOMOTIVES & THE ENGINEERING & MOTOR TRADES. 3681

Works: ASTON MANOR, BIRMINGHAM.

Tels {grams: Cylinders. phone: No. 871 & 872 E (4 lines).

SHAFTING. 8441

'PHONE: GOVAN 653-654. TELEGRAMS: "PEDESTAL, GLASGOW."

GOVAN SHAFTING & ENGINEERING CO., LTD., GLASGOW.

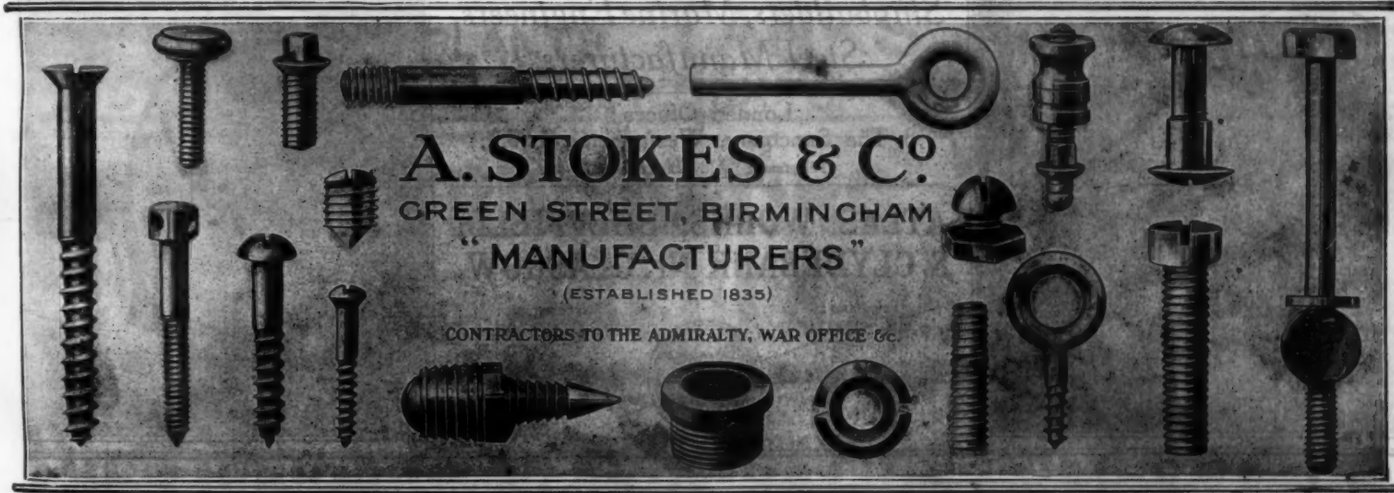
HAMMER HANDLES.

All Descriptions of Handles for Engineers' Tools manufactured by us from High Grade Material.

RIVETTING, STRIPPING, SLEDGE, HAND-HAMMER AND FILE HANDLES. 7841

ON ADMIRALTY LIST. LONG ROUND HOLDING-UP SHAFTS. CONTRACTORS TO WAR OFFICE.

GEO. DICKIE & SON, CHESTER STREET, BIRKENHEAD.



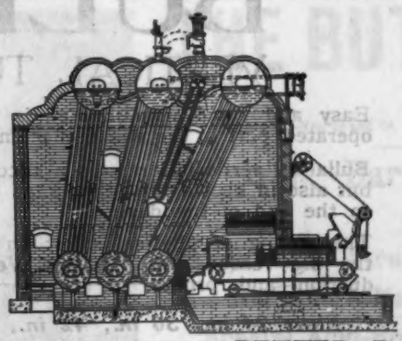
JOHN THOMPSON WATER TUBE BOILERS, Ltd.,

WOLVERHAMPTON, ENGLAND.

The BOILER for the LARGE overload capacity.

Standard Sizes in STOCK for immediate and early delivery.

Two 15,000 lbs. Boilers. Working pressure of boilers 200 lbs. per square inch, and complete with Superheaters.



We make a speciality of supplying and erecting Complete Boilerhouse Plants, from BOILER-HOUSE BASEMENT to the TURBINE STOP VALVE.

Write for New Illustrated Catalogue. 8841

YOU cannot buy a BETTER Boiler.

Telephone— 1138 WOLVERHAMPTON. Telegrams— WATERTUBE, WOLVERHAMPTON.

London Office: WINDSOR HOUSE, KINGSWAY, W.C. 2. Telephone—456 Regent.

Manchester Office: 29, WINDSOR AVENUE, FLIXTON, MANCHESTER.

UPWARDS
OF
200,000
GRESHAM'S PATENT

Telegraphic Address: BRAKE, MANCHESTER Telephone: CENTRAL No. 613.

INJECTORS

OF ALL CLASSES NOW IN USE. 8250

GRESHAM & CRAVEN, LTD., MANCHESTER.

London: 110, Cannon St., E.C. Glasgow: W. Lester & Son, 11, West Regent St. Newcastle-on-Tyne: Tangyes, Ld. Paris: W. Strapp, 15, Rue de Madrid.

JOHN BROWN & CO., LTD.

Shipbuilders, Marine Engineers, Steel Manufacturers.

London Offices:
8, The Sanctuary, Westminster, S.W.1.
Telegrams: "Aldwarke, London."

ATLAS WORKS, SHEFFIELD,
& CLYDEBANK Nr. GLASGOW.

Telegrams: "Atlas, Sheffield." Telegrams: "Shipyard, Clydebank."

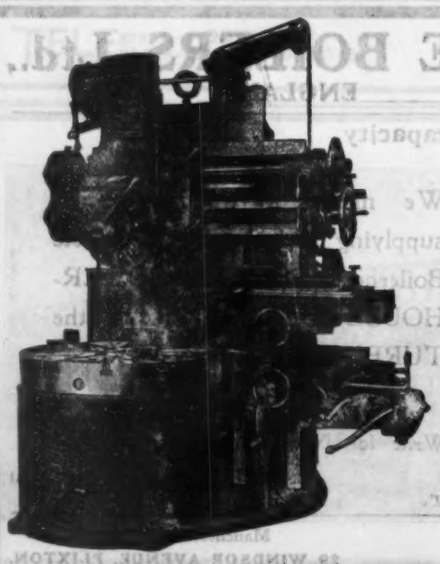
Od 3814

Put the "Prod" into Production with the

BULLARD

BULLARD

VERTICAL TURRET LATHE



Easy and rapid manipulation is the answer. There is not a hand-operated part in the whole machine which might be operated by power.

Bullard "verticals" not only succeed in "cutting time between cuts" but also in keeping the time-gaps down to the minimum right through to the end of the day.

The saving of physical effort on the part of the operator is one of the big reasons why Bullard Vertical Turret Lathes increases production—and profits.——Ask us about it. 8610

Sizes 24 in., 36 in., 42 in., 54 in. *Good Deliveries.*

The Bullard Machine Tool Co.,
BRIDGEPORT, CONN., U.S.A.

BEYER, PEACOCK & Co., Limited

London Representative:
E. S. LUARD, M.I.C.E.,
15, Dean's Yard, Westminster, S.W.
Tel. Address: "FOLGORE" Vic., London.
Telephone No. 3937 Victoria.

Gorton Foundry, Manchester.

Works Telegraphic Address: { "LOCO" Gorton.
Telephone No. 255 Manchester.
5640 Genl. Manr. and Secy's Office.

ESTABLISHED IN 1854.

LOCOMOTIVE ENGINES

FOR ALL PURPOSES AND GAUGES

GARRATT PATENT ARTICULATED LOCOMOTIVES

ALSO MACHINE TOOLS.

EMERY GRINDING MACHINES A SPECIALITY.

WITH OR WITHOUT ELECTRICAL DRIVE.

8434

WORKMANSHIP AND MATERIAL UP TO THE HIGHEST STANDARD OF EXCELLENCE.

STEEL FOUNDRY for Casting Wheel Centres and other Parts of Locomotives. Also general CASTINGS and FORGINGS

CLAYTON, SON & CO., LTD

MOOR END WORKS, HUNSLET, LEEDS.

TELEGRAMS—"GAS, LEEDS." CONTRACTORS TO H.M. GOVERNMENT. LONDON OFFICE: 5, VICTORIA STREET, S.W.1.

WELDED AND RIVETTED STEEL PIPES.

7666

BOILERS. GAS PLANTS. TANKS FOR OIL & WATER, &c.

STRUCTURAL STEELWORK OF EVERY DESCRIPTION.

ICE & REFRIGERATING MACHINERY AND INSULATION.

Land Installations.

Carbonic Anhydride and Ammonia Compression Systems.

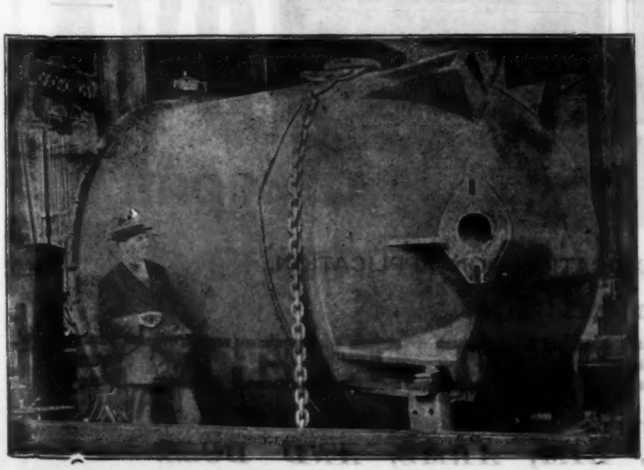
Marine Installations.

7328

THE LIVERPOOL REFRIGERATION COMPANY, LTD.

LONDON OFFICE:
London House, New London Street. E.C.

Contractors to H.M. Admiralty.
COLONIAL HOUSE, LIVERPOOL.



THE BUTTERLEY CO., LD.

DERBY. ESTABLISHED 1791.

Telephone—Nos. 75 and 76, RIPLEY. Telegrams—"Ironworks, Butterley."

Pig Iron, Bar Iron, Iron Castings up to **20 TONS.**

Bridge and Structural Steelwork, Pit Trams, &c.
High-class Machine Work of all descriptions.
Special Acid-Resisting Metal for Chemical Plants.
Large Retorts, Pans, Acid Eggs, &c., a Speciality.

LONDON OFFICE—52, Queen Victoria Street. Telephone—2180 CITY.

PECKETT & SONS, LTD.,

BRISTOL.

Telegrams . . Peckett, Bristol.

SPECIALITY

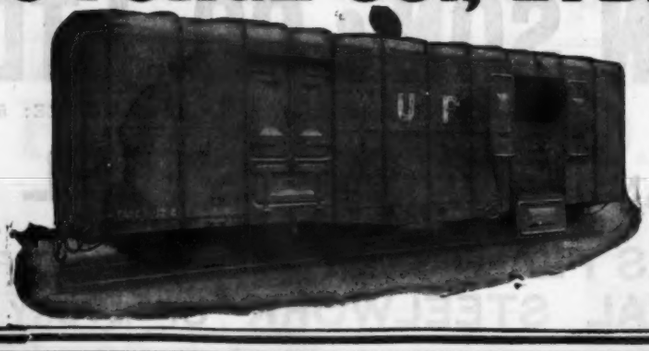
TANK LOCOMOTIVES

Of all Descriptions and any Size or Gauge.

8313 *Full Particulars on Application.*

THE LEEDS FORGE CO., LTD., LEEDS.

PIONEERS in the Design & Manufacture of PRESSED-STEEL UNDERFRAMES & BOGIES, and ALL-STEEL RAILWAY PASSENGER CARRIAGES and WAGONS.



LONDON HOUSE—
3, QUEEN ANNE'S GATE,
WESTMINSTER, S.W. 1.

UGANDA RAILWAY.

Covered Goods Wagon, with Fox's Pressed Steel Underframe and Bogies, and Lane's Patent Corrugated Pressed Steel Doors.

HUDSWELL, CLARKE & CO., LTD.,

RAILWAY FOUNDRY, LEEDS.

LOCOMOTIVES

For Main or Branch Railways, Contractors, Ironworks, Collieries, &c. Made to suit any Gauge of Railway.

Established 1860.

Tel. Address: "Loco, Leeds."

PRICES, PHOTOGRAPHS AND FULL SPECIFICATIONS ON APPLICATION.

8183

SOLE MAKERS OF

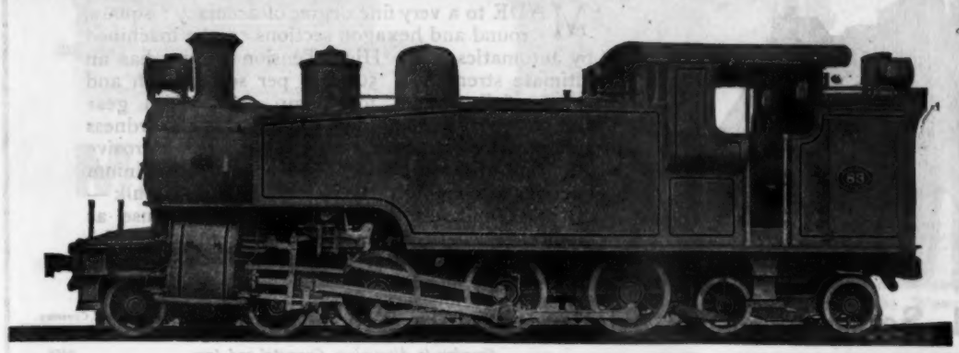
"RODGERS' PULLEYS"

(REGISTERED).

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE HUNSLET ENGINE CO., Ltd.,

LEEDS.



MAKERS OF

LOCOMOTIVE ENGINES

adapted to every variety of work and gauge.

DESIGNS & SPECIFICATIONS SUPPLIED OR WORKED TO.

Quotations and Specifications on application.

7165

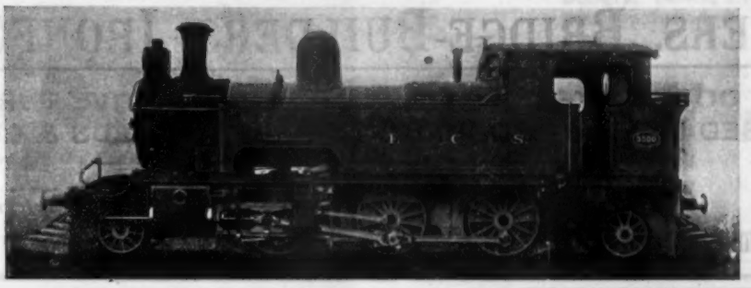
Telegraphic Address: "ENGINE, LEEDS."
Telephone: Nos. 20877 (3 lines).

ROBERT STEPHENSON & CO., LIMITED,

Locomotive Builders, DARLINGTON.

ESTABLISHED AT NEWCASTLE 1821. NEW WORKS OPENED AT DARLINGTON 1902.

LONDON OFFICE:
Sanctuary House,
WESTMINSTER, S.W.
Telegrams—
ALTISCOPE, LONDON.
Nat. Telephone—
No. 650 VICTORIA.



WORKS:
Telegrams—
ROCKET, DARLINGTON.
Nat. Telephone—
2700.
Codes—
Engineering Standards, A B C (5th Edition), Engineering Telegraph (2nd Edition), and Kendall's.

1150

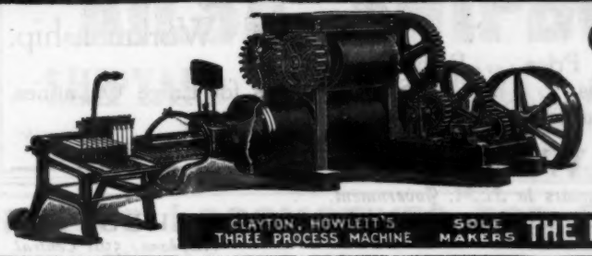
LOCOMOTIVES OF THE HIGHEST CLASS UP TO ANY SIZE AND CAPACITY.

Special Locomotives: Compound or Simple Expansion Articulated, or other Types with Flexible Wheelbase to suit any Gauge of Rail and Conditions of Service.

TELEGRAMS "CASTINGS" SHEFFIELD

BRICK TILE & PIPE MACHINERY

TELEPHONES 373 & 1233



CLAYTON, HOWLETT'S THREE PROCESS MACHINE

CLAYTON, HOWLETT & Cos AND MURRAY'S
(SIDNEY G.W. HUNTER & Co)

ILLUSTRATED CATALOGUE ON APPLICATION

LONDON OFFICE.
28 VICTORIA ST WESTMINSTER, S.W.
Teleph: 920 VICTORIA. Telegr: "BRICK PRESS CAM" LONDON.

SOLE MAKERS THE BRIGHTSIDE FOUNDRY & ENGINEERING Co LTD SHEFFIELD.

AVONSIDE

ENGINE Co., LTD.,

BRISTOL,

LOCOMOTIVES

IN STOCK AND PROGRESS.

Sterling Extruded Sections.

Aluminium, Brass & High Tension Bronze.

MADE to a very fine degree of accuracy; square, round and hexagon sections can be machined by automatics. The High Tension Bronze has an ultimate strength of 50 tons per square inch and is especially useful for pump rods, worm gear and any parts demanding a high degree of hardness and tensile strength or subject to corrosive influence of atmosphere or sea water. Aluminium Sections are one-third the weight — bulk for bulk — of brass and are especially suitable for use as mouldings where curves have to be fitted closely. The metal of the Brass Sections cuts very freely and is easily machined.

Sterling Metals Ltd., Coventry. Wires: Stermet, Coventry. 'Phone: Coventry 981.

Founders in Aluminium, Gunmetal and Iron. 6658

CONTRACTORS TO H.M. GOVERNMENT. ON WAR OFFICE, ADMIRALTY, INDIA OFFICE, and COLONIAL OFFICE LISTS. ESTABLISHED 1885.

THE BRANDON BRIDGE-BUILDING CO. LD.

ENGINEERS, BRIDGE-BUILDERS. IRONFOUNDERS.

7743

BRIDGES, ROOFS, DOCK GATES, TANKS PIERS, LOCOMOTIVE TURNTABLES & WATER COLUMNS, PRESSED STEEL TROUGHING. INGOT MOULDS & GENERAL CASTINGS.

London Office:— 34, Victoria Street, Westminster.

Works: MOTHERWELL.

Telegraphic Address: "GIRDER." *Telephone:* No. 11.

CAST IRON MAIN COCKS

HIGH GRADE TESTED.

Clean Sound Castings. ∴ Perfect Workmanship.
Right Price. Right Quality.
Produced by Up-to-date Methods. :: Special Terms for Large Quantities.
Large Stocks on hand.

8056

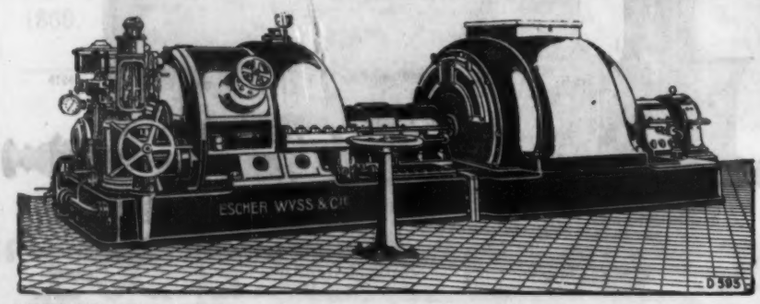
H. B. WHITE & CO.,

Contractors to H.M. Government.

JOHN DALTON STREET :: :: MANCHESTER.

Telegraphic Address: "Whiteness, Manchester." *Telephone:* 5561 *Central.*

ESCHER WYSS & Co., S.A., Zurich (Switzerland)



Zoelly Steam Turbines

Turbopumps - Water Turbines

8541

17/20

LONDON Office: 109, Victoria St., Westminster, S.W. **TOKYO** Office: 3, Uchisaiwaicho Itchome Kojimachi-Ku. **MONTREAL** Office: 612, Coristine Building.

MANNING, WARDLE & CO., LTD.

BOYNE ENGINE WORKS, LEEDS.

Makers of Locomotive Engines for any width of gauge and for all purposes. Also makers of Steam Rail Motor Coaches for passenger traffic. Materials and Workmanship of the best quality. Tank Engines up to 18 in. cylinders, on four or six wheels, always in stock or in progress. Specifications, Photos and Prices on application and Special Designs sent on receipt of particulars of requirements.

London Office: Mr. H. J. HEAGERTY Blenheim Mansions, Broadway, Westminster, S.W. 1. Od 2456

BALDWIN

A Baldwin Locomotive for the Federated Malay States Railways.

The Baldwin products include steam locomotives for all classes of service; internal combustion locomotives for light switching and special service; and such engineering supplies as parts of heavy machinery, forgings, castings, boilers, tanks, in fact, anything that can be manufactured in a large locomotive building plant.

The Baldwin policy is to give the best possible service in all respects. As far as manufacturing, shipping and financing are concerned, we are prepared to accommodate our customers in every way.

The name "BALDWIN" is a world guarantee. 8571

THE BALDWIN LOCOMOTIVE WORKS,

Philadelphia, Pa., U.S.A.

LONDON OFFICE: 84, VICTORIA STREET, S.W. 1.

Cable Addresses: "BALDWIN PHILADELPHIA." "FEIBALD, LONDON."

AILSA SHIPBUILDING CO., LTD.,

SHIPYARD, ENGINE WORKS AND GRAVING DOCKS, TROON, N.B.

TELEGRAPHIC ADDRESS:—"SHIPYARD, TROON." TELEPHONE NO. 35 TROON.

8137 BRANCH SHIPYARD WITH HEAVY HAULING UP SLIPWAY AT AYR.

FIRELESS LOCOMOTIVES FOR EXPLOSIVES & POWDER FACTORIES.

MANY TYPES
FIRELESS LOCOMOTIVES
FROM 4'-8½" TO 2'-0" GAUGE
ALREADY SUPPLIED
TO MEET
DIVERSE CONDITIONS.
See Successive Illustrations.

"TYPE 89 1273"

COAL & OIL-FIRED LOCOMOTIVES,
CRANE LOCOMOTIVES,
ARTICULATED LOCOMOTIVES.

TELEGRAMS—
"BARCLAYSON, KILMARNOCK."

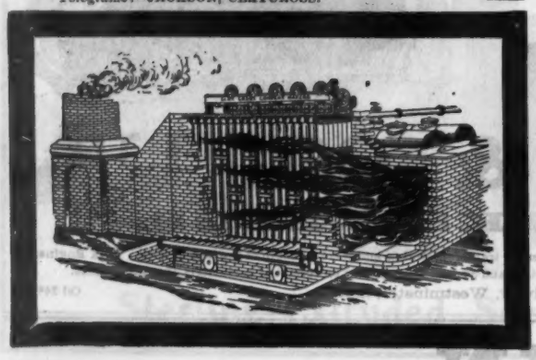
LONDON ADDRESS— 8408
59 VICTORIA STREET
WESTMINSTER S.W.

ANDREW BARCLAY, SONS & CO., Limited,

CALEDONIA WORKS, KILMARNOCK, SCOTLAND.

The Clay Cross Company, Ltd., Clay Cross, Derbyshire.

Telegrams:—JACKSON, CLAYCROSS. — ESTABLISHED 1837. — Telephone:—479 CHESTERFIELD.



MAKERS OF STANDARD-TYPE

FUEL ECONOMISERS

For Utilising the Waste Heat from Steam Boilers of all Types. 7816

SAVES IN COAL FROM 15 TO 25 PER CENT.

Adopted by Steam Users throughout the World.

ADOPTED BY ALL LEADING SHIPOWNERS & MEAT COMPANIES IN THE WORLD

REFRIGERATING MACHINERY

on the AMMONIA, CARBONIC, & COMPRESSED AIR SYSTEMS

AWARDED GRAND PRIX FRANCO-BRITISH EXHIBITION LONDON 1908

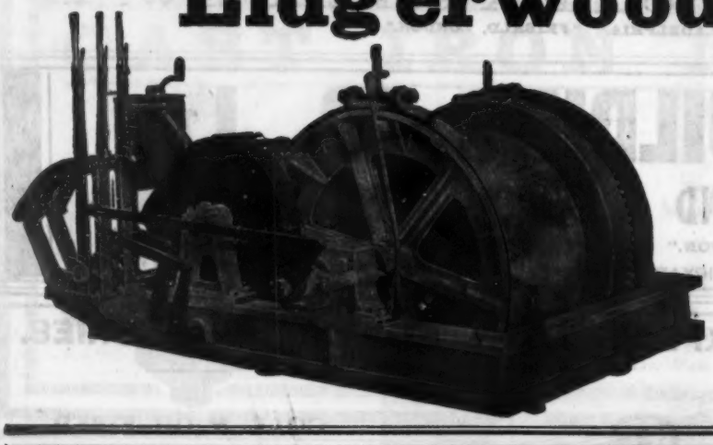
Ice Plants up to 200 Tons Capacity

UNION FOUNDRY, DERBY. London Office:— 175-177, SALISBURY HOUSE, LONDON WALL, E.C.

THE HASLAM FOUNDRY & ENGINEERING Co. Ltd.

Od 1448

Lidgerwood Mine Hoists.



STEAM and ELECTRIC HOISTS

For Every Mine Service.

Steam built up to 1000 HP. Electric built in any size.

The design, material and labour in every part of Lidgerwood Hoists will easily withstand the strain falling upon them when the hoist is working to its full capacity

STEAM & ELECTRIC HOISTS FOR ALL PURPOSES.

Catalogues on application.

Lidgerwood Mfg. Company,

Friars House, New Broad Street,
LONDON, E.C.

9041

Manufacturers of SIEMENS' ACID STEEL

BOILER PLATES.

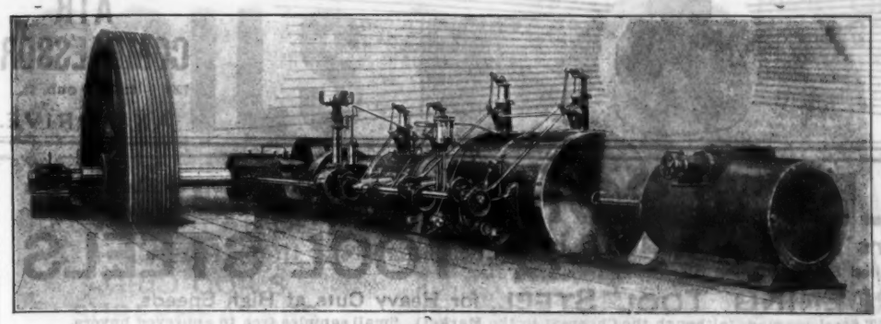
Also SHIP and BRIDGE PLATES, ANGLES, BULBS, CHANNELS, ROUNDS, SQUARES, TEES, ZEDS, &c.

BILLETS, of dead soft quality, and for wire and springs or special quality, from any grade of carbon; also SLABS.

THE GLASGOW IRON & STEEL CO., LTD.,

WISHAW SCOTLAND.

8005



800 HORSE POWER TANDEM DROP-VALVE ENGINE. 8529

NEWTON, BEAN & MITCHELL,

Engine Builders and Millwrights,

DUDLEY HILL, **BRADFORD.**

Telegrams: "ADROIT, DUDLEY HILL."
'Phone: 135 DUDLEY HILL (3 lines).

STANDARDISED MANUFACTURES

TANDEM, CROSS COMPOUND, and VERTICAL ENGINES.

All with our Improved Piston Drop Valves

CONDENSING PLANT.

TRANSMISSION MACHINERY

Of all kinds.

ENGINES INDICATED & DETAILED REPORTS PREPARED

We invite enquiries and correspondence, which shall have our best attention at all times.

JOHN THOMPSON, (WOLVERHAMPTON) LTD., WOLVERHAMPTON

(LANCASHIRE)

IMMEDIATE DELIVERY:

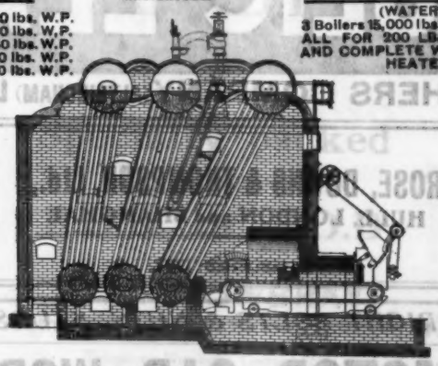
4 30ft. x 9ft 3in. x 120 lbs. W.P.
3 30ft. x 8ft. 6in. x 160 lbs. W.P.
1 30ft. x 8ft. 6in. x 150 lbs. W.P.
6 30ft. x 8ft. 6in. x 120 lbs. W.P.
2 30ft. x 8ft. 6in. x 100 lbs. W.P.

(WATERTUBE)

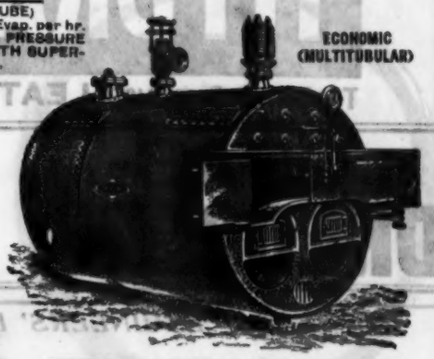
IMMEDIATE DELIVERY.

(WATERTUBE)

3 Boilers 15,000 lbs. Evap. per hr. ALL FOR 200 LBS. PRESSURE AND COMPLETE WITH SUPERHEATER.



ECONOMIC (MULTITUBULAR)



STANDARD SIZES READY FOR IMMEDIATE DELIVERY.

BOILERS OF ALL TYPES. 8070

£50,000 SURPLUS FOR SALE.

Enquiries are invited for:

60 Machine Tools, Grinders, Lathes, Capstans, Drilling Machines, Woodworking Machines, Presses (hydraulic and hand), various others.

7 Tyre Press, Power Units, completely self-contained, consisting of 5 b.hp. 2 Cylinder Austin Engine with forced lubrication, geared down (12 to 1) to two Hollings & Guest Hydraulic Plunger Pumps, designed for a working pressure of 1 ton per square inch. These sets could be easily altered for an increased capacity with a lower water pressure, and are suitable for any kind of pumping duty. The petrol consumption is 3 pints per hour.

6 Motor Boat Engines.

24 200 hp. Austin-Sunbeam 8 cylinder petrol motors, built by the Austin Motor Co., 120 by 130, three valves per cylinder, adaptable for Motor Boats or Country House, Fire Extinguishers, etc.

4 320 hp. 12 Cylinder Austin Petrol Motor, very suitable for fast light motor boat (Hull), 130 by 150 Copper Water Jackets.

500 Complete Steering Gears for Commercial or other vehicles.

31 Petrol Tanks, capacity about 18 and 12 gallons each.

56 Electric Starters, by C. A. V., Rushmore; Brolt & Gray, and Davis.

A quantity of Ball and Roller Bearings, Bolts and Nuts, Oil Pressure Gauges, Taper Pins, &c., &c.

Applications to be made to the SERVICE DEPT.

A quantity of Brass Bearing Shells (lined white metal), Steel Shafts, Brown Wheels, Gear Wheels, Brass Bushes, &c, also a number of old Petrol Tanks and general Engineering Sundries.

56 Lorry Steel Wheels (front and rear).

130 Dunlop Solid Rubber Tyres, 720 by **100.**

1400 Steel Rims, all sizes.

150 815 by **105** complete **Wood Wheels** with **brake drums.**

150 760 by **90** ditto.

60 760 by **90 Wood Wheels,** plain.

50 880 by **120 Sankey-Austin Wheels.**

100 Rudge-Whitworth detachable Wheels, 880 by **120** and **820** by **120.**

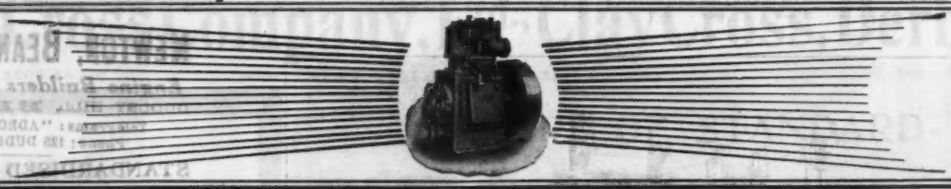
25 Rear Wheels with (Twin) **Warland Rims.**

30 Front do. (Single) do. **935** by **135.**

THE AUSTIN MOTOR CO., LTD.

LONGBRIDGE WORKS, NORTHFIELD, BIRMINGHAM. H 348

BROOM & WADE LTD. **HIGH WYCOMBE.**
Phone: 345-346 (2 Lines)



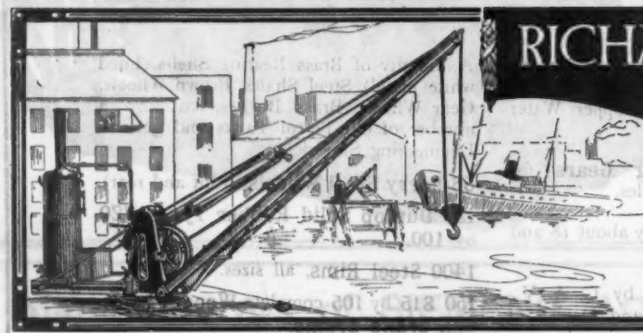
AIR COMPRESSORS
7995 to 1000 cub. ft.
ANY DRIVE.

JAMES FAIRLEY & SONS, LTD.,
General Steel Manufacturers and SPECIALISTS in **TOOL STEELS**
Contractors to His Majesty's and other Governments.
Invite attention to their Unrivalled Self-Hardening Steel.
FAIRLEY'S SELF-HARDENING TOOL STEEL, for Heavy Cuts at High Speeds,
is considered to be the HARDEST and TOUGHEST Steel yet made (although the Cheapest in the Market). Small samples free to approved buyers.
NOTE.—JAMES FAIRLEY & SONS, Ltd., Works (Bramall Lane, SHEFFIELD, & Mill St. Forge and Rolling Mills, BIRMINGHAM) are merely Branch Departments and All Communications should be addressed to the Head Offices—OLD MINT, SHADWELL STREET, BIRMINGHAM. Od 1719

ON ADMIRALTY, WAR DEPT AND COLONIAL LIST
HYDRAULIC LEATHERS
THE BRITISH SPECIALISTS **LEATHERS COMPANY (ALTRINCHAM) LIMITED, ALTRINCHAM**

GRAB-DREDGERS.
ROSE, DOWNS & THOMPSON, Ltd.,
HULL, LONDON and SHANGHAI.
ESTABLISHED 1777.
OIL MILLS.
8373

Manufacturers of ENGINEERS' BRIGHT BOLTS & NUTS, STUDS, SET SCREWS, &c. *of all kinds.*
AIRCRAFT AND MOTOR CAR WORK SPECIALITIES.
Manufacturers to Principal Engineers and Engine Builders.
REPETITION WORK IN ALL METALS FOR CAPSTANS & AUTOMATICS. 8366
Telegrams: "DANGERFIELD, GOLDTHORN HILL, WOLVERHAMPTON."
W. & J. DANGERFIELD,
Albert Works, Goldthorn Hill, WOLVERHAMPTON.
PROMPT DELIVERIES.
SEND US YOUR ENQUIRIES.

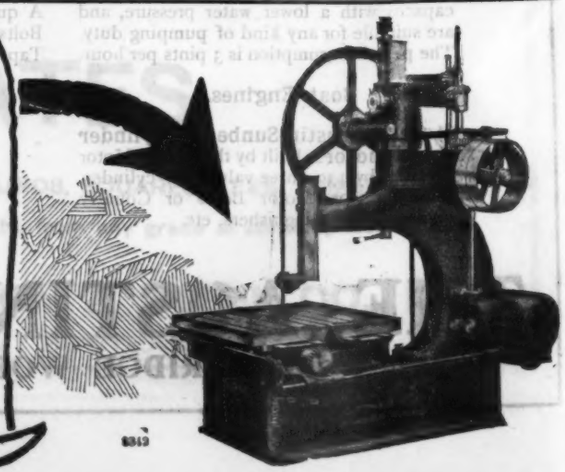


RICHARD C. GIBBINS & Co.,
Berkley Street,
BIRMINGHAM.
Makers of Steam Electric & Hand Cranes.
All kinds of Lifting Tackle.

O 1891

No cuttings can drop into the Gearing
of this Patent Top Driven Band Saw. This means a big saving in the expense of constant renewals of costly parts. Another advantage is that the Saw Pulleys are fitted with Ball Bearings, which economise power and eliminate wear.

Clifton and Baird LTD
Empress Works, Johnstone, Scotland,
SPECIALISTS IN METAL SAWING MACHINERY.
Your Enquiries are Invited.



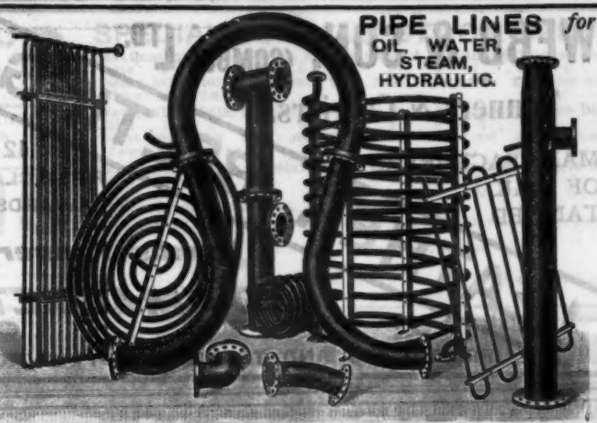
8349

COILS

OF
EVERY DESCRIPTION

RECTANGULAR COILS
CIRCULAR COILS
GRID COILS
SUPERHEATERS

Works: Glengall Road, Millwall, E.14



PIPE LINES *for*
OIL, WATER,
STEAM,
HYDRAULIC.

COILS

SPECIALISTS IN
TUBE BENDING

BRANCHES, 7908
BENDS, HEADERS,
EXPANSION PIECES

PROMPT DELIVERY.

YOUR ENQUIRIES SOLICITED:— THE MILLWALL ENGINEERING CO., LTD., 21, PANTON ST., LONDON, S.W. 1.

WIRE ROPE

from 1/16" to 1/2 diameter
LARGEST STOCKS
QUICKEST DELIVERY
LOWEST
PRICES

READY FOR EXPORT

Specially packed
Delivered
F.O.R or F.O.B

F. H. MOWBRAY
14 Southampton Street, Strand, London, W.C

Telephone Number: Gerrard 8620,
Telegraphic address: EFFEMBRAI, PHONE, LONDON.
CODE A.B.C. & BENTLEY'S COMPLETE PHRASE.

SPRING WIRE

from 10 to 33 B.W.G
LARGEST STOCKS
QUICKEST DELIVERY
LOWEST
PRICES

H202

BRAITHWAITE & Co.

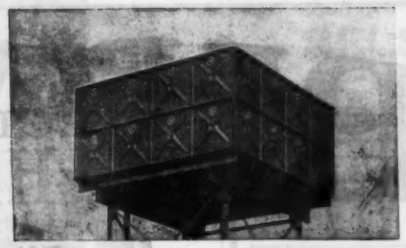
117 VICTORIA ST. LONDON, S.W.1

WORKS

CROWN BRIDGE WORKS
WEST BROMWICH, STAFFS
CONSTRUCTORS OF
STEEL·BRIDGES
STEEL·JETTIES
STEEL·BUILDINGS
STEEL·STRUCTURES
STEEL·GIRDERS

NEPTUNE WORKS
NEWPORT, MONMOUTHSHIRE
SPECIALISTS IN
PRESSED·STEEL·WORK
PRESSED·STEEL·TANKS
PRESSED·STEEL·FLOORING
PRESSED·STEEL·CULVERT·PIPES
PRESSED·STEEL·SLEEPERS

PORTABLE·&·LIGHT·RAILWAY·MATERIALS



Pressed Steel Tanks made in 4 feet and metre Square Segments. 7507

CONSOLIDATED CONSTRUCTION COMPANY, LTD.

AMALGAMATING THE CONSTRUCTION DEPARTMENTS OF

DICK, KERR & CO., LTD. AND J. G. WHITE & CO., LTD.

TELEPHONE: CITY 8176
TELEGRAMS "SOLCONSTRU, CANNON, LONDON."

UNDERTAKES CONSTRUCTION CONTRACTS OF ANY MAGNITUDE OR DESCRIPTION IN THE UNITED KINGDOM OR ABROAD.

Agents in Argentine, Australia, Brazil, China, Ecuador, Mexico, New Zealand, United States, Uruguay, Venezuela, &c., &c.
Also connections in all Countries.

9, CLOAK LANE,
CANNON ST.,
LONDON, E.C. 4.

8404

CONTRACTS EXECUTED BY THE CONSTITUENT COMPANIES EXCEED £20,000,000.

SYDNEY SMITH & SONS
(Nottingham), Ld. 7939
Basford Brass Works,
NOTTINGHAM.
Write for Catalogue illustrating great variety of
BOILER MOUNTINGS
For MARINE, STATIONARY and PORTABLE ENGINES and BOILERS.

JOHN SPENCER, LD.
8530 WEDNESBURY.
IRON & STEEL
TUBES
POLES, STEAM MAINS, TUBULAR PILES, &c.

WEBB & SON, (COMBS) LTD.
Tanners & Curriers.
MANUFACTURERS OF OAK TANNED
LEATHER BELTING.
12 FIRST-CLASS AWARDS.
Combs Tannery,
STOWMARKET.
8306
PRICE LISTS AND TERMS ON APPLICATION.

MARINE ENGINEERS AND BOILER MAKERS.
DAVID ROWAN & CO., LD.
231, Elliott Street, 8335 GLASGOW.
Telegrams—"ROWAN, GLASGOW."
Cable Codes—A B C (4th & 5th Editions). LIEBER'S.

GAS PRODUCERS.
STEEL FURNACES.
SHELL FURNACES.
See Last Week's Advertisements. 7232
Send for particulars to—
G. P. WINCOTT, LTD.,
180, ATTERCLIFFE ROAD, SHEFFIELD.

Solid Drawn Brass & Copper Tubes, Locomotive & Condenser Tubes, Muntz's Metal Sheathing, Braziers' Sheets, Circles, Bolts, Pump Rods, Plates, Nails, Washers, Naval Brass Sheets, Plates, Rods, &c.

Contractors to Admiralty.

P. H. MUNTZ'S PATENT

P. H. MUNTZ & CO., LTD.,

LONDON OFFICES:
80, GRACECHURCH STREET E.C.

Alexandra Works, 8606
WEST BROMWICH.

BERWICK ELECTRIC RIVET HEATER

No. 3. Three-Electrode Berwick Heater. For rivets ½ in. to 1 in. diameter, up to 4½ in. long or longer. Capacity about 300 hot rivets per hour, depending on size. Right other types and sizes for various requirements.

Eliminates open fires, smoke, gas, dirt, and intense heat.

The Berwick Heater has hot rivets ready in 20 to 30 seconds after starting. No smoke, no fumes—nothing to hamper the workmen.

It cuts down burning and scaling of rivets to less than ½ of 1 per cent.

It saves 20 to 70 per cent. of operating cost, as compared with fuel-burners.

Easily portable and can be placed close to the work.

Uses power only when hot rivets are needed. Heats each rivet independently and uniformly; radiation from centre outward.

Absolutely safe—easy to operate—practically no wearing parts or maintenance expense.

No. 2. Two-Electrode Berwick Heater. For rivets ½ in. to ¾ in. diameter, up to 3½ in. long or longer. Capacity about 350 hot rivets per hour, depending on size.

Send for Catalogue.

American Car and Foundry Company,
165, Broadway, New York, U.S.A.

GARDNER'S TOOL BARGAINS

FIRST LIST. Watch for the next.

GARDNER'S
CENTURY TOOL WORKS, BRISTOL.
Phone: Bristol 2294. Telegrams: "Tools Bristol."

SPECIAL SURPLUS STOCK OFFER

Best Quality ½" dia. British Association (B.A.) Standard Circular Dies.

Size	0	1	2	3	4	5	6	7	8	9
Quan.	800	2,400	1,600	600	2,000	2,600	1,800	400	200	200 only

Price All @ 2/4 each.

Best Quality 1" dia. British Association (B.A.) Standard Circular Dies.

Size	0	1	2	3	4	5	6	7	8	9
Quan.	200	1,750	2,100	400	1,900	1,800	600	400	400	400 only

Price All @ 3/- each.

Best Quality British Association (B.A.) Dies, Circular, Left Hand, ½" dia.

Size	0	1	2	3	4	5	6	7	8	9
Quan.	96	199	204	526	199	328	100	100	100 only	

Price All @ 2/4 each net.

Best Quality 1" dia. British Association (B.A.) Circular Dies, Left Hand.

Size	0	1	2	3	4	5	6
Quan.	99	199	186	100	264	195	245 only

Price All @ 3/- each.

The above prices are subject to substantial discounts for large quantities on receipt of specification. (1)

CASTINGS

BRASS, GUN-METAL, PHOSPHOR AND MANGANESE BRONZE.

DANIEL YOUNG, WITNEY, OXFORDSHIRE
On Admiralty List. 8031

GUNMETAL SCRAP

bought or re-melted into castings.
HUNT & MITTON, Ltd.,
BRASSFOUNDERS' BRASSFINISHERS. 8080
Gorsells Street North, BIRMINGHAM.

RICHARD INDICATOR.

RELIABLE BOURDON STEAM GAUGES
High Speed Indicators.
BUCHANAN'S ENGINE COUNTERS.
Engineering Instrument Manufacturers.
HANNAN & BUCHANAN
75, Robertson St., GLASGOW.

EXTRUDED BARS "DELTA" BRAND

BRONZE, YELLOW METAL, BRASS, RED METAL, NAVAL BRASS, COPPER, &c.
THE DELTA METAL CO., LTD., EAST GREENWICH, LONDON, S.E. 10.
DELTA WORKS,
And at BIRMINGHAM. 8076

"LEGGE'S" MANGANESE PASTE.

Reliable under the most adverse conditions
ENSURES POSITIVE CONTROL OVER

Steam, Gas, Water and Air

Fittings, Flanged and Screwed Joints.

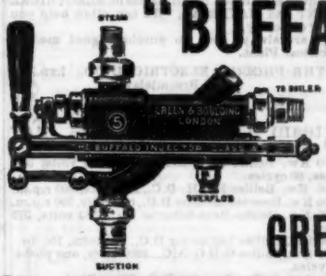
Supersedes Red Lead. 8047
F. THOMPSON LEGGE & CO.,
16, South Castle Street, LIVERPOOL.

WALTER NEWBOLD & CO. Ltd

(Proprietors of Newbold's Machine Tool Co.),
22, Martin Lane, Cannon St., London, E.C.4.
Telegraphic Address:—NEWBOLD, LONDON.

LATHES and MACHINE TOOLS of every description Also WOODWORKING MACHINERY. Established 1885. 8129

"BUFFALO" INJECTOR



Lifts 24 ft.

TAKES HOT WATER.

Illustrated Catalogue with prices and full particulars of both classes of Injectors and Tripp's Metallic Packing on application.

GREEN & BOULDING Ltd.,
ENGINEERS, Od 9498
28, New Bridge Street, London, E.C. 4.
Telegrams—TEMPERATURE, LONDON
Telephone—12455, CENTRAL.

THE "CLIMAX" COLLET CHUCK

Capacity ⅝ in. diam.

Collets of various sizes can be furnished.

IN STOCK.

With this Attachment any hollow-spindle lathe can be readily fitted with a
Draw-in Collet Chuck.
The Shank (No. 3 Morse Taper) fits into spindle in place of the "centre."

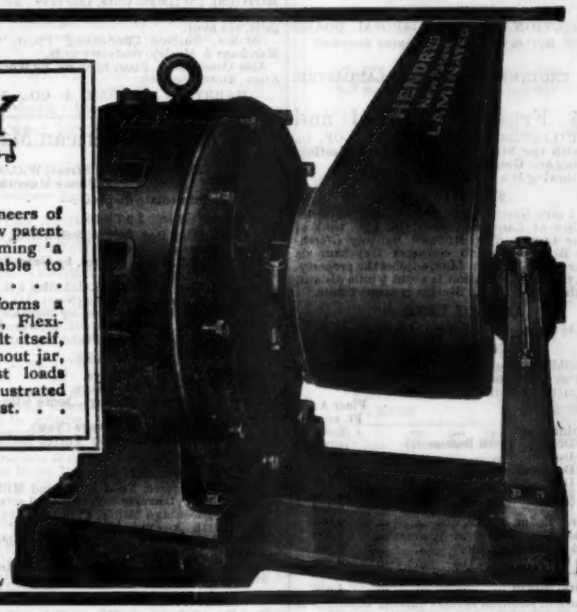
SELSON
Engineering Co., Ltd.,
83-85, QUEEN VICTORIA STREET, LONDON, E.C. 4. 2461

HENDRY
FROM A SINGLE STRAND
BELTING

ONE of the leading Electrical Engineers of the day describes HENDRYS' new patent Laminated Leather BELTING as forming 'a true Endless Belt which is adaptable to universal service.' . . . . . .

The Hendry ENDLESS SPLICE forms a joint identical in Texture, Thickness, Flexibility and Driving Grip with the belt itself, so that a HENDRY BELT runs without jar, vibration or slip under the heaviest loads and at the highest speeds. Illustrated booklet, samples and prices on request. . .

JAMES HENDRY, LTD.
292 Main Street
Bridgeton, GLASGOW



Copyright Registered 8205

SAFETY FIRST!

AVOID ACCIDENTS BY USING

TRIER'S "UNIVERSAL" SAFETY REST

ADJUSTABLE IN EVERY WAY. 4083
ENTIRELY OF MALLEABLE IRON.
REST FREE TO SWING BACK AND INSTANTLY RELEASE HAND OR TOOL.

BRUNTON & TRIER,
36, Victoria Street, London, S.W. 1.

BIRMINGHAM BATTERY & METAL Co LTD.

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM.
SEAMLESS & BRAZED 8045 TUBES
FOR BOILERS, CONDENSERS, &c.
TELEGRAPHIC ADDRESS: "BATTERY, SELLY OAK."

For Sale, Belt-driven Trans- PORTER CRANE, with telescopic jib to lift 30 cwts. Can be seen at work at DEWAR'S WHARF, Waterloo Bridge, London, S.E. 1. H 289

Cast Steel Plates, all one size, 16½ in. long by 4½ in. wide by ¾ in. thick, 65 tons to clear quickly. New material, never been used, and in excellent condition, equal to No. 3 temper; full analysis on application. For immediate sale will accept low price of £30 per ton, f.o.r. London. — THOS. W. WARD, LTD., Silvertown, London, E. 16. H 281

For Sale, Two Stage, Recipro- CATING AIR COMPRESSOR, in excellent working condition. A.E.G. make, output 883 cubic feet per minute at 85-33 lbs. pressure, driven by an asynchronous three-phase motor, 940 kw. 5000 volts, 50 periods.—For full particulars address SOCIETE DES MINES DE SOUMONT, 16, Boulevard Malesherbes, Paris. H 199

Portable Oil Furnaces Save Money for Garages, Plumbers, Fitters, Tinsmiths, Builders, etc. We Offer as Bargains, balance of American Army Stock, new and perfect, substantial W.I. Frame, 7 pint Brass Container, well-made lamp, and 7 inch C.I. melting pot, at clearance price, £5 5s. each, carriage paid (less liberal trade discount), while stock lasts. Reduction on quantities.—Write for particulars, PARKER, WINDER AND ACHURCH, LTD., Birmingham H 159

The Following Plant for Sale:

Six STEAM SALVAGE PUMPS, from 12 in. to 6 in. Suction, and large quantity Rubber and Steel Suction and Delivery Pipes.

Three STEAM DIRECT-DRIVEN AIR COMPRESSORS, 12 in. and 10 in.

SEVERAL SMALL VERTICAL ENGINES and STEAM PUMPS.

One 12 in. BONACCORD BELT-DRIVEN CENTRIFUGAL PUMP, 8 ft. Galley Range.

WIRES, TIMBER, etc.

Can be seen in Glasgow. Offers Wanted.

Address:—BOX 100,
PETER A. MENZIES,
Advertising Agent, Glasgow.

H 302

For Sale, Steel Twin-screw BUCKET HOPPER DREDGER "NEWPORT," capacity of hopper 550 cubic yards; dredges to a depth of 50 feet.—Apply for full particulars and price to JAMES HYES, Shipping Contractor, Agent for the Sale, Purchase, Construction and Chartering of Steamers, Steam Trawlers, Tugs and Barges, Shipping Auctioneer and Valuer, 15, Manor Avenue, Great Grimsby. Telegrams: "Ships, Grimsby." Telephone 3028 Grimsby.

FOR SALE, Steel Twin-screw Combined Bucket and Suction HOPPER DREDGER "FAMAGUSTA," capacity of hopper 500 cubic yards; dredges to a depth of 40 feet.—Apply for full particulars and price to JAMES HYES, as above.

FOR SALE, Single-screw STEEL SALVAGE and TOWING TUG, very powerful.—Apply for full particulars and price to JAMES HYES, as above. H 166

FOR SALE:

Three Lancashire Boilers, 30 ft. by 7 ft. 6 in. diameter, reinsure 140 lbs. pressure.

One ditto, 30 ft. by 7 ft. 6 in. diameter, reinsure 120 lbs. pressure.

One ditto, 28 ft. by 7 ft. diameter, reinsure 90 lbs. pressure.

Two Vertical Waste Heat Cochrane Boilers, 16 ft. 6 in. by 6 ft. diameter, reinsure 100 lbs. pressure.

One Fuel Economiser, 120 pipes, reinsure 130 lbs. pressure.

One Cast-iron Tank, 14 ft. by 7 ft. by 4 ft. deep.

One Circular Open-top Pan, 10 ft. diameter by 10 ft. deep.

Several Dish-ended Cylinders, each 6 ft. by 2 ft. diameter, tested hydraulically to 150 lbs. pressure.

40/50 Buoys, 4 ft. long by 2 ft. 9 in. dia. by ¼ in. thick.

17 New Pitched Steel Roof Principals, 31 ft. 6 in. span overall.

CATALOGUE of Stock MACHINERY, 2-3000 LOTS, free on application. Inspection invited. 8537

THOS. W. WARD, LTD., ALBION WORKS,
Tel. "Forward, Sheffield." SHEFFIELD.

Hugh Wood & Co., Ltd.,
DEPT. N.,
NEWCASTLE-ON-TYNE.
Tel. Add.: "Huwod," Newcastle-on-Tyne.
Tel.: 980 Central, Newcastle-on-Tyne.

Have available for Immediate Delivery,

AUXILIARY HAULAGE GEARS, ELECTRIC, COMPRESSED AIR, or STEAM-DRIVEN.

Several 15 HP. ELECTRICALLY-DRIVEN HAULERS, 500 volts, 50 periods, or alternatively 500 volts, D.C. equipment.

Several 10 HP. ELECTRICALLY-DRIVEN HAULERS, complete with 500 volts, 50 periods, or alternatively 500 volts, D.C. equipment.

Several STEAM or COMPRESSED AIR HAULAGE ENGINES, double drums, cylinders 7 in. bore by 9 in. stroke.

One 3½ ton Jeffrey Electric Accumulator Standard Gauge LOCOMOTIVE.

One 2½ ton Jeffrey Electric Trolley Standard Gauge LOCOMOTIVE.

Also available for Immediate Delivery.

Several "Huwod" Portable Compressed Air-driven CENTRIFUGAL PUMPS.

"Huwod" Pneumatic Pick Axes, Coal Cutter Hose, &c., &c.

Also for Early Delivery.

One 24 in. by 24 in. Jeffrey SINGLE ROLL CRUSHER or BREAKER, having a capacity of, approximately, 70 tons of coal per hour.

One Jeffrey SWING HAMMER PULVERIZER, having a capacity of 60 tons of coal ½ in. to dust per hour.

Jeffrey Self-propelling WAGON and TRUCK LOADER, suitable for loading coal, coke, sand or similar material. 6975

HUGH WOOD & CO., LTD.

For Sale.—Proceedings of Inst. C.E. 1896 onwards, and Proceedings of Inst. Mech. E, 1900 onwards.—C.D., 4, College Road, Isleworth. H 333

For Sale.—

HYDRAULIC PRESS, ram about 18 in. dia., Jack ram 5 in. dia., working pressure one ton per square inch, made by Fielding & Platt.

HYDRAULIC PRESS, ram 33 in. dia., 12 in. stroke, working pressure three tons per square inch, made by Hydraulic Engineering Co.

HYDRAULIC PRESS, ram about 24 in. dia., 24 in. stroke, working pressure one ton per square inch.

Seen in London. Low prices for quick sale.—Write, GEO. COHEN, SONS & CO., 600, Commercial Rd., London. E 14. H 189

New Churchill Type 10 in. by 24 in. UNIVERSAL GRINDERS.

New Landis 10 in. by 26 in. PLAIN GRINDER.

No. 11 Brown & Sharpe PLAIN GRINDER.

No. 4 Cincinnati UNIVERSAL MILLER, capacity 12 in. by 64 in.

Heald 16 in. PISTON RING GRINDERS.

Pratt & Whitney THREAD MILLER, 6 in. by 14 in.

Archdale PLAIN MILLER, single pulley drive, table 25½ in. by 10 in.

Kempsmith No. 2 PLAIN MILLER, table 40 in. by 10 in.

No. 3 Le Blond UNIVERSAL MILLER, table 52 in. by 12 in.

Hendey No. 4 UNIVERSAL MILLER, single pulley drive, table 56 in. by 15 in.

Archdale VERTICAL MILLER, table 48 in. by 12 in., single pulley drive.

No. 1 Brown & Sharpe PLAIN MILLER, table 35 in. by 10½ in.

9 in. Centre Fay AUTOMATIC LATHES, bed 8 ft. by 3 ft., hollow spindle.

New 12½ in. centre 13 ft. 2 in. Gap Bed SS. & SC. LATHE, with hollow spindle.

24 in. swing Gisholt SS. & SC. LATHES, bed 11 ft. 4 in., square turret.

LO SWING LATHE, all gear drive, 3½ in. by 84 in. capacity.

New Gardner 22 in. CRANK PIN TURNING MACHINE.

6A Potter & Johnson CHUCKING AUTOMATICS.

No. 6 Fellows GEAR SHAPER.

No. 14 Cochrane bly UNIVERSAL SHAPER.

36 in. Schneider VERTICAL DRILL.

New 6 in. stroke SLOTTING MACHINE, self-acting feeds.

JOHN MACNAB (MACHINERY), LTD.,
Hyde. Tel.: 78 Hyde.
London Office: 7, King Street, Cheapside, E.C. 2.
Birmingham Office: 40, Bennett's Hill. 7776
Manchester Warehouse: Sophia St., Rochdale Road.

G. R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD (LANDS, BUILDINGS AND FACTORIES SECTION).

CATON ENGINEERING WORKS, LANCASTER.

The Freehold Land and BUILDINGS TO BE DISPOSED OF, together with the Fixed Power, Lighting, Heating, Ventilating and Generating Plant.

The following is a brief description:—

SITUATION.

About 1 mile North and slightly East of the centre of the City of Lancaster, near the East bank of the River Lune. The Midland Railway (North-Western Branch), which connects Heysham via Lancaster with the Main Line, adjoins the property. Green Ayre (M.R.) Station is about ¾ mile distant, and Castle (L. & N.W.R.) Station is about 1 mile.

AREA OF LAND.

About 5¾ acres.

CONSTRUCTION.

The Buildings are mostly of stone construction with timber and slate roofs, and also concrete floors. The principal buildings comprise:—

	Floor Area. Ft. super.
Machine Shop	30,000
Do. (with Basement)	10,000
Do.	9,000
Do.	8,700
Do.	5,700
Do.	4,500
Do.	3,600
Control Room, Stores, etc.	9,000
Foundry	7,500
Sheet Metal Shop, etc.	7,300
Main Office	6,800
Canteen	5,100
General Stores	4,800

There are in addition several smaller buildings of various sizes.

Total floor area of the buildings about 172,000 ft. super.

SIDINGS.

Full gauge sidings are laid down in the Works, and are connected with the Midland Railway.

LIGHTING AND POWER.

Electric and Gas.

HEATING.

Low pressure Steam.

WATER.

Town supply.

Further particulars and plan may be obtained on application to THE CONTROLLER, Lands and Factories Section, Disposal Board, Charing Cross Buildings, Embankment, London, W.C. 2.

NOTE.—For particulars of other Government Property for Sale see *Surplus*, price 3d. at all bookstalls; or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. H 283

For Sale, Motor Generator by the Electrical Construction Co., consisting of 500 volt D.C. motor, coupled to 350 Kw. 110 volt, D.C. Generator, 580 r.p.m., complete with switchboard. Can be seen at work during next few weeks. —The PHŒNIX ELECTRICAL CO., LTD., 32-36, Broomielaw, Glasgow. F 596

For Sale.

COMPLETE WORKS ELECTRIC POWER AND LIGHTING PLANT.

In perfect condition and very little used, comprising:

One 15 Kw., 110 volt, Westinghouse Compound Wound D.C. GENERATOR.

One 200 amp. Ironclad SWITCH PANEL, containing D.P. Switch and Fuses, Volt and Ammeters, and Shunt Resistance, all totally enclosed and mounted on Channel Iron uprights.

One 5 HP., 110 volt, 1400 r.p.m., Swedish Shunt Wound MOTOR, complete with 7 in. by 3½ in. pulley, slide rails, and D.A. Igranic Starter.

One 8 way, 10 amp., H.D. DISTRIBUTION BOARD, mounted on slate and enclosed in teak case, together with the whole of the exterior and interior cables, switches, fittings, shades, etc., etc.

Address, Z.E.620, c/o Messrs. DEACON'S Advertising Offices, Leadenhall Street, London, E.C. H 345

Electrical Plant For Sale.

GENERATING SETS, 100 to 1000 Kw., Direct Current; 300 to 750 Kw., 3-phase, 50 periods.

MOTORS, A.C. and D.C., All types, &c., up to 300 HP.

ROTARY CONVERTERS, TRANSFORMERS, &c., &c.

Enquiries solicited for all classes of ELECTRICAL PLANT and MATERIAL. We can often help you out of difficulty.

We are always open to purchase good modern Electrical Plant.

THE PHŒNIX ELECTRICAL CO., LTD.,
32-36, Broomielaw,
Glasgow. 8030

Steam Generating Sets For SALE.

750 Kw. Belliss-Dick, Kerr A.C., 2200 volts, one phase, 60 cycles.

500 Kw. Belliss-B.T.H. D.C., 220 volts, 300 r.p.m.

500 Kw. Browett-Lindley D.C., 500 volts, 300 r.p.m.

300 Kw. Belliss-Rees-Roturbo D.C., 580 volts, 375 r.p.m.

250 Kw. Belliss-Lahmeyer D.C., 220 volts, 150 lbs.

250 Kw. Belliss-G.B.C. A.C., 2200 volts, one phase, 60 cycles.

170 Kw. Belliss-Siemens D.C., 220 volts.

90 Kw. Belliss-Dick, Kerr D.C., 550 volts, 500 r.p.m.

75 Kw. Bellis-Holmes, 110 volts, 680 amps., D.C., complete with Condensing Plant.

60 Kw. Allen D.C., 220 volts, 400 r.p.m.

23 Kw. NEW BALANCER SET (ELECTRO-MOTORS), 230/115/230 volts, 1250 revs., 200 amps.

Two Weir Type Pumps, by Mather & Platt, 2500 galls. per hour.

800 Kw. Surface Condensing Plant, by Cole, Marchant & Morley, complete unit.

Also Condensing Plant in stock, by Worthington, Allen, Stott, etc., etc.

HARRY H. GARDAM & CO., LTD.,
Staines. F 575

The Anglo-American Machine TOOL SUPPLY CO.,
20, Great Russell Street, W.C. 1.
'Phone Museum 2044.

Have for immediate disposal:—

LATHES.

Ten 6½ in. Gap Bed Lathes, S.S. & S.C., 6 ft. Bed, various makers.

Two 8½ in. S.S. & S.C. Lathes, by Dean Smith and Grace.

One 10 in. Gap Bed S.S. & S.C. Lathe, 5 ft. between centres, 1½ in. Hollow Spindle (New).

One Double Geared Lathe, by Shank's S.S. and S.C., Swing 6 ft. in gap, take 4 ft. between centres.

Five 5 in. Holbrook Brass Finishers' Lathes.

CAPSTANS.

Two ¾ in. Pratt & Whitneys.

Four No. 1 Warner & Swaseys.

36 No. 2 Warner & Swaseys, some with chasing attachment.

Four No. 4 Warner & Swaseys (New).

Two Cincinnati Acme Flat Turret Lathes, 2½ in. Hollow Spindle.

MILLERS.

One Heavy Geared No. 4 Richmond Miller, table 44 in. by 13½ in., traverse 3 ft. Vertical attachment.

One No. 1 Denbigh Miller, 42 in. by 10 in. table.

One Smith & Coventry, Model "C," Vertical Miller and Profiler, 4 ft. 6 in. Rotary table, 4½ in. Spindle.

One Brown & Sharpe No. 5 Vertical Miller.

Six No. 1 "Burke" Bench Millers.

GRINDERS.

One No. 12 Brown & Sharpe Universal Grinder, Fully equipped.

One Modern 6 ft. by 36 in. Plain Grinder, fully equipped.

One Rivett No. 205 Radial Grinder for Ball Races.

GEAR CUTTERS.

One No. 3A Cincinnati Gear Cutter.

One Bevel Gear Shaper to cut gears up to 6 in. dia., Reinekes.

PLANERS.

One Redman Planer, 8 ft. by 2 ft. 6 in. by 2 ft. 6 in.

Two Backton Planers, 14 ft. by 5 ft. by 3 ft. 9 in.

AUTOMATICS.

Two ¾ in. Four Spindle Gridleys.

Four 1¼ in. Four Spindle Gridleys.

Three 1½ in. Four Spindle Gridleys.

Three 2½ in. Four Spindle Gridleys.

Two No. 33, New Britains.

16 ⅝ in. Clevelands.

10 ¾ in. Clevelands.

Also ¾ in., 2½ in., 2¾ in. and 3¼ in. ditto.

Set of Three Bretts' Drop Hammers, 30 cwt., 15 cwt. and 30 cwt. H 284

Steam Engine for Sale, Hori- zontal, 18 in. by 30 in., trunk guide, expansion valve, governor, modern, perfect.—MARSHALL, 55, Bath Street, Glasgow. H 163

A Time Recorder, as New, guaranteed, latest model. WHAT OFFERS?—A. G. PELLEY, 149, Farringdon Road, E.C. 1. F 599

For Immediate Sale, Instant DELIVERY.—One New Modern Set Plate Bending Rolls, to bend plates 10 ft. long by ¾ in. thick.—JOHN H. RIDDELL, LTD., 40, St. Enoch Square, Glasgow. G 486

Steam (All Types) Boilers. All Sizes 8315
Vertical, Loco., Cornish, Launch, Field-tube; also Air Receivers, Feed-Water Heaters, Cylinders, &c.—THE GRANTHAM BOILER & CRANK CO., Ltd., Grantham

For Sale, Quick Delivery, THREE NEW HIGH SPEED LATHES, 8½ in. Centres by 8 ft. Gap Bed, 3 in. Hollow Spindle, Square Steel Turrets.—DINGLEY, PARSONS & CO., Guildhall Buildings, Birmingham. G 815

Transformers for Sale.— Three New 1875 K.V.A. 6600/440 volt, 50 cycle, 3-phase "Berry" Oil Cooled Transformers.
THE PHŒNIX ELECTRICAL CO., LTD.,
32-36, Broomielaw,
Glasgow. G 475

Willson.

GENERAL REPAIR LATHES.

Willson 10 ft. Gap Bed Lathes (8 in. centres) allow a 33 in. diameter swing, and thus are specially adapted to general repair work.

Illustrated catalogue on request.

SMITH BARKER & WILLSON LTD.,
North Moorside, Halifax.
'Phone: 46. Wire: "Lathe" Halifax.

F 598

For Sale.—Powerful Horizon- TAL Belt-driven Twin AIR COMPRESSOR, capacity 985 cubic feet.

One Horizontal Steam-driven AIR COMPRESSOR by the Chicago Pneumatic Tool Co., capacity about 150 cubic feet.

One Horizontal Steam-driven AIR COMPRESSOR, by Larmuth, capacity 350 cubic feet.

Two "Eclipse" Compressed Air ROCK DRILLS, with Swivel Bars and Adjusting Screws.

One Horizontal Steam-driven AIR COMPRESSOR, by the Consolidated Pneumatic Tool Co., Ltd., capacity about 285 cubic feet, 100 lb. pressure.

One Alley & MacLellan Vertical AIR COMPRESSOR, Series "B," Belt-driven, capacity 250 cubic feet.

One Belt-driven AIR COMPRESSOR, 9 in. cylinder, 11 in. stroke, by The Chicago Pneumatic Tool Co.

Also Several BELT and STEAM-DRIVEN COMPRESSORS, capacity from 10 cubic feet upwards.

JOHN H. RIDDELL LTD.,
40, St. Enoch Square, Glasgow.

For Sale.—One Jones and Lamson 24 by 2 FLAT TURRET LATHE.

Two "Gisholt" TOOL GRINDERS.

Six Girder Wall Radial DRILLING MACHINES, 1¾ in. spindles, to drill 1 in. holes.

One Powerful PLANING MACHINE, to plane 24 by 5 by 5 ft.

Powerful Radial DRILLING MACHINE, 3½ in. spindle, 9 ft. arm.

One "Landis" Plain GRINDING MACHINE, admits 32 in. between centres.

One 24 in. Lang's SURFACING AND BORING LATHE.

One Pair 9 in. Cylinders Diagonal ENGINES.

One Massive BORING AND SURFACING LATHE, by Tangye, swings 7 ft. diameter.

One Horizontal STEAM WINCH, 6 in. cylinders, with warping ends.

Several Sets Patent Roots BLOWERS, with iron revolvers, different sizes.

One 8 cwt. Massey STEAM HAMMER, overhung type.

Two 8 in. centres by 8 ft. Straight Bed SLIDING, SURFACING and SCREW-CUTTING LATHES, by John Lang & Sons, Johnstone.

One Boilermakers' 2-cwt. "Massey" Patent Welding STEAM HAMMER, for welding flues, tubes, &c.

One Modern Jones & Shipman 30-in. Heavy Duty Vertical DRILLING MACHINE.

One 2 cwt. Single Standard "Rigby" Type STEAM HAMMER, 6 in. cylinder, 15 in. stroke.

One No. 0 Foster CAPSTAN LATHE, wire feed, for ¾ in. bar.

One Duplex Horizontal Cylinder BORING MACHINE, capable of boring two cylinders simultaneously from 6-in. to 18-in. diameter.

One "Ryder" 4-Hammer FORGING MACHINE

One Excellent SHAPING MACHINE, 12 in stroke.

One Set Geared Three-throw PUMPS, motor-driven, brass rams 3 in. diameter; motor 1.25 HP., 200 volts.

One New "Sturtevant" 36 in. Belt-driven FAN, pulley 4 in. diameter.

One Small Blackmann Ventilating FAN, complete with ¼ HP. motor and starter.

Modern Horizontal BORING and TAPPING MACHINE, by Lang of Johnstone, 2½ in. spindle.

One Alldays' "Empire" Positive Pressure BLOWER, 8 in. outlet.

One Set 14 ft. PLATE BENDING ROLLS.

One S.S.S.C. LATHE, 8½ in. centres, 6 ft. gap bed.

One 15 cwt. Loco. STEAM CRANE, by Butters.

One New Set 10 ft. PLATE BENDING ROLLS.

One Plate Edge PLANING MACHINE, to plane plates 19½ ft. long.

Two 3 Ton Electric Shipyard WINCHES, all complete.

JOHN H. RIDDELL LTD.,
40, St. Enoch Square, Glasgow. 3423

For Sale, Six Modern Gas ENGINE GENERATING SETS, with 440 volt, D.C. Generators, from 220 to 500 Kw. output.—Address, H 183, Offices of ENGINEERING.

For Sale, 75 Ton, 41 ft. 6 in. Span, three-Motor ELECTRIC OVERHEAD TRAVELLING CRANE.—Address, H 184, Offices of ENGINEERING.

For Sale, Three-throw Vertical PUMP by H. P. Vacher, Winchester. Bronze cylinders, 3 in. by 9 in., geared 1·4, fast and loose pulleys, all in excellent condition and little used. Can be seen by appointment.—ESTATE OFFICE, Bedales, Petersfield, Hamp hire. H 246

For Sale, Two Sets Inverted TRIPLE EXPANSION ENGINES, cylinders 22 in., 34 in., and 51 in. dia., with Surface Condensers. — For full particulars apply, THOS. W. WARD, LTD., Albion Works, Sheffield. H 185

For Sale, Patent Rights modified 2A Type Semi-collapsible Lifeboat, passed Board Trade. — Address, PATENT, WM. POITEOUS & Co., Advertising Agents, Glasgow. H 188

For Sale, Vertical Table ENGINE, about 7 HP. Can be had at once.—Send offers to JAMES LYNE HANDCOCK, LTD., 266 Goswell Road, London, E.C. 1. H 323

Engineering Works, Reading, with Frontage to River Kennet, comprising FACTORY, WORKSHOPS, DWELLING-HOUSE, etc. Price FREEHOLD £5000, or with EXTENSIVE PLANT £5750. — MESSRS. F. WARMAN, Highbury, N. H 316

Second-hand Two Tons "Johnson" STEAM JIB CRANE, capacity two tons, at 14 ft. radius; Wheelbase 5 ft. 7 in., Gauge 4 ft. 8½ in., Jib 24 ft. long, Cylinders 6 in. diameter by 9 in. stroke, Wire Rope 44 yds. long by ¾ in. diameter. Boiler pressure, 80 lbs.—THOS. FIRTH & SONS, LIMITED, Stores Dept., Norfolk Works, Sheffield. H 317

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Gear Cutting Machines. The Proprietors of British Letters Patent No. 108520, are PREPARED to SELL the PATENT or to licence British Manufacturers to work under it. It relates to machines for cutting gears or pinions of the curved herring bone type, and particularly to the mechanism controlling the relative motions of cutter and blank.
Address: BOULT, WADE & TENNANT, 111 & 112, Hatton Garden, London, E.C. 1. H 314

1300 Tons New Slightly
DEFECTIVE
STEEL FLANGE RAILS,
About 95 lbs. per Yard,
With Fishplates.
Ready for prompt Delivery.
Inquiries Invited.
Address:—THOS. W. WARD, LTD., Sheffield. H 318

Black Mild Steel Flat Bars.

4 in. by 3 in.,	90 tons.
4 in. by 1½ in.,	70 tons.
4 in. by 1¼ in.,	40 tons.
2½ in. by 1½ in.,	80 tons.
2½ in. by 1¼ in.,	150 tons.
2 in. by 1 in.,	12 tons.
2 in. by ¾ in.,	12 tons.

Also some intermediate sizes.
All New material, in good condition, being only stock rusty, price £26 per ton, f.o.r. London.
For immediate clearance of big lots—
THOS. W. WARD, LTD., Silvertown, London, E. 16. H 332

Engineering Business For SALE in thriving Town, 30 miles from London. Perfectly planned modern premises, abutting on Main Railway, from which private siding could be constructed. There are well-equipped offices with staff, plating, and enamelling plants stocks of materials, loose tools, &c., and fixed machinery. The Works are in operation, employing about 60 workpeople, and are capable of great and immediate development under efficient administration. Cash required about £10,000. Factory premises can be purchased also if desired. Definite reasons for selling. Principals only should apply, in first instance by letter, to BOX 904, c/o POTTER'S Advertising Agency, Imperial House, Kingsway, London, W.C. 2. H 320

Direct Current Motors for SALE.
Variable Speed Type with Brookhirst Control Panels.
THREE—7½ HP. 220 volt, 450/900 Revs. B.T.H. £128.
EIGHT—19½ HP. 440 volt, 500/1000 Revs. Crompton. £145.
THREE—16 HP. 240 volt, 400/1200 Revs. Peebles. £155.
SEVEN—16 HP. 240 volt, 400/1200 Revs. Lancashire. £160.
FIVE—18 HP. 440 volt, 210/630 Revs. Westinghouse. £228.
TWO—20 HP. 440 volt, 310/930 Revs. Lancashire. £210.
THREE—24 HP. 440 volt, 400/1600 Revs. Lancashire. £210.
TWO—25 HP. 250 volt, 200/600 Revs. Lancashire. £240.
TWO—34 HP. 250 volt, 300/600 Revs. Lancashire. £295.
THE PHŒNIX ELECTRICAL CO., LTD., 32/36, Broomielaw, Glasgow. H 36

For Sale, New Shipyard, N.W. area, with Five Berths to take ships up to 200 ft., ample shops, offices, mould loft, saw mills, canteen, and usual accommodation. Site 4 acres, ample land adjoining for extension. — Address, H 136, Offices of ENGINEERING.

Three-Spindle Driller, £48. Bright new 2in. self-opening DIEHEAD, £10. Phosphor Bronze ROD, ½in. dia...3¼ cwt., at 1s. 4d. lb. Carpenter and Fitters' BENCHES. Drawing-Office OAK CABINET, £9. Fire Resisting SAFE, £14. SPLIT PULLEYS, 14 in. to 27 in. TIMBER, 8 in. by 5 in., 7 in. by 4 in., and 9 in. by 4 in. 5 cwt. PLATFORM SCALES, £9. Spindle-straightening PRESS, £7. Write, 36, Leadale Road, N 16. H 299

A Troughton & Sims Theo- DOLITE, wooden case and leather cover, £40. Stanley LEVEL, wooden case, £15. Both as new. 16 ft. Sopwith STAFF.—PHILIP POORE, 1, Paternoster Row, E.C. 4. H 356

PATENTS AND DESIGNS ACT, 1907 AND 1919.

ELECTRIC STOP-WELDING.

The Proprietor of British Letters Patent No. 107758 is PREPARED to SELL the PATENT or to license British Manufacturers to work under it. It relates to a process of electrically spot-welding plates of different thicknesses and consists in applying the welding current through electrodes of different contact areas.
Address:—Messrs. BOULT, WADE & TENNANT, 111-112, Hatton Garden, London, E.C. 1. H 308

Advertiser Invites Offer for REGULAR QUANTITIES of WELDLESS TUBE ENDS, 4 in. diameter by 6 to 9 gauge thick, in lengths of 3 to 12 inches.—Address, H 358, Offices of ENGINEERING.

Shaft Lathe, by Bucktons, For SALE, 16 in. centres to take 26 ft. between centres, two saddles, latest all geared type. Address, H 359, Offices of ENGINEERING.

PLANT FOR SALE.

One Brown and Sharpe No. 4 Automatic Spur Gear Cutting Machine, 48 in. capacity, £900. Two Webster & Bennett 6½ in. by 6 ft. Gap bed, S.S. and Screwcutting Lathes, £100 each. Can be seen in operation.—Address, H 360, Offices of ENGINEERING.

For Sale.—Boiler, Babcock and Wilcox double drum, heating surface 1741 sq. ft., evaporation 7000 lb. water per hour, 160 lb. pressure, one feed water heater, piping.
GENERATING SET, Tandem compound engine 8½ in. and 14 in. by 8 in. stroke, 110 B.HP., 420 revs., 160 lb. steam, direct coupled to Mavor & Coulson Dynamo, compound wound multipolar, 600 amps., 100 volts.
DROP HAMMER, one 7-cwt. steam drop hammer, 160 lb. pressure automatic action by foot trigger.
All above for Immediate Delivery.
Can be seen our works.
MAVOR & COULSON, LTD., Glasgow. H 366

For Sale, Weir High Pressure Vertical FEED PUMPS, gun-metal boxes, from 8 in. to 14 in. steam cyls., 8 in. and 12 in. stroke.
Vertical FAN ENGINES by Allen, Thwaites & Brotherhoods, 5 in. to 7 in. cyls., 4 in. to 5 in. stroke, with or without Fans, approx. from 3 ft. to 8 ft. 6 in. diam.
CAPSTAN ENGINES, 5 in. to 6 in. cyls., 5 in. and 6 in. stroke, vertical bollards about 12 in. by 12 in.
STEAM STEERING ENGINES, 5 in. cyls., 5 in. and 6 in. stroke.
STEAM GENERATING SETS, 8, 15 and 100 Kw. by Bellis, Morcom, Allen & Brotherhood, 80 and 105 volts D.C.
AUXILIARY CONDENSING SETS complete.
THOS. W. WARD, LTD., Albion Works, Sheffield. H 355

One "D" 3 Kearns High Speed Surfacing, Boring, Milling and Drilling Machine. Face up to 42 in. diameter, 3½ in. spindle. Main Table 60 in. by 36 in. Detachable Table 42 in. by 42 in. (revolving). Longitudinal traverse 60 in., Transverse Traverse 48 in., Bed 8 ft. 6 in. long. Arranged for Motor Drive through Double Helical Gear. AS NEW.
One No. 11 "SUNDERLAND" Gear Planer by Parkinson. Cut 6 ft. diameter by 10½ in. face, pitch up to 3 in. Complete with Change Gears, and arranged for Motor Drive. AS NEW.
One No. 6 "FELLOWS" Gear Shaper, complete with Change Gears and Countershaft. AS NEW.
One "HERBERT" No. 9 Combination Turret Lathe, single Pulley drive, complete with Standard Tools, taper attachment, 15 in. Coventry Chuck, 16 in. four paw Independent Chuck and extra Tools. AS NEW.
One No. 13 "HERBERT" Hexagon Turret Lathe, single Pulley Head, Double Teggle Chuck and complete equipment including 2 in. Coventry Die Head and Dies. AS NEW.
One 12 in. by 50 in. "CHURCHILL" Universal Grinder, maximum swing 12 in., maximum length 50 in. Complete with internal grinding fixture and Countershaft. AS NEW.
One 3 ft. 6 in. radius "CINCINNATI" Bickford Radial with Base and swinging table 26 in. by 16 in., power elevation to Arm, Spindle to base maximum 4 ft. 3 in., minimum 14 in. Complete with 5 speed cone countershaft. GOOD CONDITION.
One 6 ft. radius GIRDER RADIAL DRILLING MACHINE, Central Thrust type, 2¾ in. diameter spindle, arranged for Motor Drive. NEW.
Apply—
McKENDRICK & COMPANY, Oakfield Works, Motherwell. H 369

Clean Your Offices with a Sturtevant No. 5 Cleaner—

the most powerful Vacuum Cleaner of its size on the market.

It will sweep smooth floors or carpets with equal ease, and can be used for cleaning books, pigeonholes, shelving, files, &c.

In the workshop it can be used for blowing dust out of motors, cleaning out store bins, &c.

It digs deep where a broom cannot go, and draws the dust from cracks and inaccessible corners.

A Sturtevant means health and cleanliness; it is— The Clean Way to Clean.

Delivery from Stock. Write for Catalogue D 1207. 8235

Sturtevant
Engineering Co., Ltd.,
147, Queen Victoria St., LONDON.

BRAIME'S CELEBRATED SEAMLESS STEEL OIL-CANS.

Over 120,000 of these Oil-Cans and Lamps have been supplied to the British Admiralty.

SEAMLESS ELEVATOR BUCKETS, *SHOP TOOL STANDS, &c.*

SPECIALITIES:—
Seamless Steel Oil-Cans.
Folded Bottom Oil-Cans
Seamless Steel Reaper Oilers.
Ships' Hand, Bunker & Space Lamps,
Seamless Steel Elevator Buckets. [&c.
Riveted Steel Elevator Buckets.
Steel Rollers for Conveyors, &c.
Seamless Steel Shop Boxes, Trays, Suds Pans, Oil Drippers, &c.
Engineering Pressings in all Metals.
Pressings for Motor Cars, Wagons, &c.
Sheet Metal Spinners.

Stamped Seamless Steel Elevator Buckets.

Telegrams: "SEAMLESS" LEEDS

Supplied through 7444 **1000 Sizes.** Merchants, Machinery Dealers, &c.

SOLE MAKERS **T. F. BRAIME & CO., Ltd., Hunslet, Leeds.**

CASTINGS.

Gunmetal—Phosphor & Manganese Bronze, &c
Engine and Boiler Mountings.
Lighthouse and Fog Signal Engineers.
STEVEN & STRUTHERS
GLASGOW, SCOTLAND. 8042
See our Illustrated Advertisement on June 11 and July 9.

MISCELLANEOUS.

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS and EVERY OTHER DESCRIPTION OF RAILWAY AND TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON AND BRASS CASTINGS, PRESSED STEEL WORK OF ALL KINDS.
Registered Office and Chief Works: Motherwell.
London Office: 14, Leadenhall Street, E.C. Od 3383

Crane and Sling Chains up to 4 in. dia. iron, also Electric Welded Chains, Blocks and Crab Winches for cranes or ropes, Screw Jacks, Patent two-speed Hydraulic Jacks, Hooks, Swivels, Shackles, General Smiths' work. Estd. 1841. —FELLOWS BROS., LTD., Cradley Heath, Staffs. 8268

DIALS

STEAM GAUGE DIALS, INDICATING MACHINE DIALS &c. 8091
JAMES COOKE & SON,
8 & 9, WRENTHAM ST., BIRMINGHAM.
Specialists in Dials. Est. 75 Years.
'Phone: Mid. 1611. Grams: "Horology," Birmingham

RIVETTERS
INTENSIFIERS
CRANES
ENGINES
LIFTS
ELECTRIC PUMPS
ELECTRIC CRANES
DEFLECTING VALVES
SHEARS
FORGING PRESSES
OVERHEAD CRANES
RELIEF VALVES
TANK PUMPS
OIL PRESSES
OVERHUNG FLANGERS
LEATHERS
SPARES
TOOLS
FOR
LEEDS
PHONE-2362
CODE-A.B.C. 5TH.
EVERYTHING HYDRAULIC.
TELEGRAMS "PRESS" LEEDS

6870

LONDON OFFICE:
3, St. Helen's Place, E.C. 3.
Telegrams:
"PROMPTITUDE, LED, LONDON."
Telephone:
AVENUE 5113 & 5114.

BALDWINS LTD

LONDON WORKS:
Orchard Place, Blackwall, E.
Telegrams:
"SILVERINE, POP, LONDON."
Telephone:
EAST 1074 & 1075.

MANUFACTURERS OF ALL KINDS OF
TANKS, CISTERNS, CYLINDERS, &c.

GALVANIZED
CORRUGATED SHEETS.

DRUMS, KEGS, CANS, &c.

GALVD. CORN BINS.

GALVANIZED
PETROL STORAGE BINS.

GALVANIZED
FLAT WORKING-UP SHEETS.

C.R. & C.A. BLACK SHEETS.

GALVANIZERS
of all kinds of IRONWORK.

Sole Makers of LEECH'S PATENT WELDED CISTERNS, SINKS, TROUGHS, &c.

8087

THIS tape never unravels, is waterproof and extremely clean to handle, contrasting with those sticky tapes that ooze blackness and cling more to the fingers than the joint.

7884

Silvertown
No. 860
Adhesive Tape,
Strong-Reliable-Economical
The India Rubber, Gutta Percha and Telegraph Works Co., Ltd.
(The Silvertown Co.)
Head Office: 106, Cannon Street, London, E.C. 4.
Works: Silvertown, London, E. 16.

THE cotton fabric used is the very best obtainable for the purpose. Send for sample tin and List No. 27.
Delivery from Stock of standard widths—
½ in., ¾ in., and 1 in.

8513

Chief Draughtsman.—A well-known firm of Engineers REQUIRES a CHIEF DRAUGHTSMAN for Electrical Travelling Cranes. Only experienced men need apply.—Address, H 304, Offices of ENGINEERING.

Capable Draughtsman REQUIRED for Iron and Steel Works.—Apply, stating age, experience and salary required, to CHIEF DRAUGHTSMAN, APPLEBY IRON Co., Scunthorpe, Lincs. H 305

Draughtsman Wanted, with experience in ELECTRIC LIFT WORK.—Apply by letter, stating age, experience and salary required, to WAYGOOD OTIS LTD., 54 & 56, Fetter Lane, E.C. 4. H 374

Draughtsman Required for London Office. Experienced in designing Steel Framed Buildings and Structural work generally.—Reply by letter, stating age, experience and salary required, to BOX 600, HASSAFORD & GOODMAN, Ltd., 57, Ludgate Hill, London, E.C. 4. H 290

Wanted, Draughtsman, used to Chemical Plant, and preferably with some experience in industrial research. Salary about £6 10s. Sound theoretical training in engineering subjects essential.—Address, H 305, Offices of ENGINEERING.

Wanted, Competent Leading DRAUGHTSMAN for high-class engine work, fully experienced man accustomed to design. State age, experience and salary required.—Address, H 296, Offices of ENGINEERING.

Draughtsmen, Senior, REQUIRED, with sound mechanical, general knowledge and shop-training. Preference given to those with cement works experience.—State age, experience and salary required to BOX 1311, WILLINGS, 125, Strand, W.C. 2. H 330

Mechanical Draughtsman WANTED at once by Consulting Engineers in London. Salary offered £350 per annum or according to ability. Workshop experience and technical training essential, experience in equipment of factories and power house design an advantage. With application send copies only of testimonials (which will not be returned), and state age, experience (fully) and when at liberty.—Write, H. C. H., at HORNCASTLES, 60, Cheapside, London, E.C. 2. H 328

Civil Engineering DRAUGHTSMAN REQUIRED for about six months, should be thoroughly conversant with the use of level and other surveying instruments, and with the design of structional steelwork.

Write stating age, particulars of experience, salary required, enclosing copies of recent testimonials to—

THE SUPERINTENDING CIVIL ENGINEER, H.M. Dockyard, Chatham. H 326

Wanted, First-class Junior JIG DRAUGHTSMAN by a firm of Engineers in Bristol. Must have had shop and drawing office experience. State age, details of experience and salary expected.— Address, H 351, Offices of ENGINEERING.

Good Draughtsmen with Civil Engineering experience REQUIRED, able to make calculations, and detail reinforced concrete and structural steelwork.—Address, giving full particulars of age, experience, salary required, etc., to BOX 3331, c/o BROWNE, 39, Tothill Street, Westminster. H 337

Structural Draughtsman WANTED for India. State age, full particulars of training and experience and when at liberty. Full information as to salary required, agreement and passage will be sent applicants.—Address, Z.J. 654, c/o Messrs. DEACON'S, Leadenhall Street, London, E.C. H 372

Draughtsmen Required for service on the UGANDA RAILWAY by the GOVERNMENT OF THE EAST AFRICA PROTECTORATE. Salary £400 per annum. Quarters free of rent, free passages. Liberal leave in England on full salary. Candidates, age 23 to 35, should have had experience in a Civil Engineer's Office, and have general knowledge of mathematics and graphic statics, also of general engineering work, such as designing buildings, bridges, sheds, laying out of station yards, plotting railway locations, etc.; they should also have served in some branch of H.M. Forces during the late war, unless their reasons for not doing so are entirely satisfactory.—Apply at once, by letter, stating age and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, and quoting M/8670. H 384

Engineering Draughts- MAN REQUIRED by the GOVERNMENT OF THE FEDERATED MALAY STATES, for Service in the Public Works Department, for three years with possible permanency. Salary 400 dollars per month, rising by 25 dollars annually to 450 dollars per month, with a temporary war bonus of 20%. (The sterling value of the dollar is at present fixed by the Government at 2s. 4d.). Free first-class passages. Candidates, single, 23-32, who must be fully trained Engineering Draughtsmen with at least five years' experience in the office of a practising Civil Engineer (a Diploma or Degree of Engineering or Science will be accepted in lieu of longer experience), capable of making calculations for structural steelwork in bridges, buildings, &c., should apply at once (by letter), giving age and brief details of experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1., quoting M/F.M.S. 9530. Candidates must have served in some branch of H.M. Forces during the late War, unless satisfactory reasons for not having done so can be furnished. H 382

Two Carriage and Wagon DRAUGHTSMEN WANTED for Railway Works in India. State age, full particulars of training and experience and when at liberty. Full information as to salary, agreement and passage will be sent applicants.—Address, Z.P. 650, c/o Messrs. DEACON'S, Leadenhall Street, London, E.C. H 373

The Sudan Government RAILWAYS AND STEAMERS DEPARTMENT REQUIRE the SERVICES of TWO DRAUGHTSMEN—one trained in a Locomotive Draft Office and one in Marine Works. Rate of pay £E 300 rising to £E. 528 per annum, plus a temporary war bonus of £E. 120 per annum. No income tax is charged in the Sudan.

(£E. 1 = £1 0s. 6d. sterling.)

Applicants should be well trained and able to do general work.

The posts are pensionable.

Strict medical examination.

Age between 25-30 years.

Free passage provided.

Copies of testimonials to accompany the application, which should be marked "S.G.R. Draughtsmen" and addressed to the office of

SIR A. L. WEBB, K.C.M.G., Queen Anne's Chambers, Westminster, S.W. 1. H 413

The Sudan Government RAILWAYS AND STEAMERS DEPARTMENT REQUIRE the SERVICES of a BOILER MAKER FOREMAN.

Rate of pay £E 324, rising to £E 528 per annum, plus a temporary war bonus of £E 120 per annum. No income tax is charged in the Sudan.

(£E 1 = £1 0s. 6d. sterling).

Applicants should have been trained on a British Railway and have experience in running shed work, boiler repairs and patching, and be thoroughly skilled in heavy boiler repairs.

The post is pensionable.

Strict medical examination.

Age between 25-33 years.

Free passage provided.

Copies of testimonials to accompany the application, which should be marked "S.G.R. Boiler Maker Foreman," and addressed to the office of :—

SIR A. L. WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, S.W. 1. H 412

Wanted, Bodymakers, for Light Car work, used to steel panels and aluminium mouldings. TRIMMERS, for open cars (some with experience of cape car-hood covering). Top district rates paid. Good factory conditions.—Apply, HANDLEY PAGE, LTD., Cricklewood, N.W. 2. H 303

Wanted, for Foundry, special on Loco. Castings, in the North of England, FIRST-CLASS FOREMAN Moulder—Address, stating age, experience, salary, &c., H 409, Offices of ENGINEERING.

SITUATIONS WANTED.

The Royal Engineers Civil Employment Registry SOLICIT the ASSISTANCE of all employers of labour to place men who have served in that Corps into civil employment. Applications for men of all classes and trades will receive prompt attention.—Apply to THE SECRETARY, R.E.C.C.A., Horse Guards, Whitehall, S.W. 1. H 379

Assistant Works Manager, Metallurgist, (B.Sc.) 27, with five years' works experience, DESIRES POSITION.—Address, H 275, Offices of ENGINEERING.

General Manager, With varied experience in Shipbuilding, light Constructional Work and Mechanical Engineering, accustomed to taking charge of Works employing up to 2000 hands; Drawing Office, Estimating, Costs and Buying Departments; will shortly be OPEN for RE-ENGAGEMENT. Highest references as to personal character and ability.—Address, H 196, Offices of ENGINEERING.

Mechanical and Electrical Engineer, with 16 years' experience in the management of tramway and lighting undertakings, municipal and company, at home and abroad, DESIRES POSITION of RESPONSIBILITY in this country.—Address, G 845, Offices of ENGINEERING.

Engineer, M.I.Mech.E. (41), with 25 years' experience, at present holding position of Loco Works Manager with important Ry. Co., DESIRES CHANGE. Speaks Spanish, and would accept suitable position at home or abroad.—SKELTON, 136, Kingston Road, S.W. 19. H 239

Civil Engineer, Norwegian, speaking English and Spanish, nine years in South America, the last four years in Denmark and Norway, with first-class theoretical education, and long experience in reinforced concrete, channel and harbour work, DESIRES EMPLOYMENT. Salary, £500. First engineer in construction firm in Christiania.—Address, H 164, Offices of ENGINEERING.

Mechanical Engineer (29), Ex-Officer, single, 13 years shops, D.O., and technical staff, DESIRES POSITION of Responsibility abroad. Would return to Russia immediately opportunity offers.—Address, H 281, Offices of ENGINEERING.

Spain.—Engineer, English- man (26), now in Barcelona, DESIRES Immediate APPOINTMENT in responsible capacity (technical, industrial or commercial), preferably in Spain. Whitworth Exhibitioner, Graduate I.Mech. E. and I.E.E. Eight years' general mechanical and Electrical experience. Three years' military service (commissioned), M.C. and mention. Some knowledge Spanish, French and Portuguese. Highest references.—Address, H 300, Offices of ENGINEERING.

Engineer, Mechanical experi- ence home and abroad, keen, energetic and practical, SEEKS POST where mechanical knowledge is essential. London preferred. Salary to commence £3 0.—G. E., c/o W. H. SMITH & SON, 169, Finchley Road, N.W. 3. H 339

Advertiser, good experience, SEEKS POSITION in Purchasing Dept., or with Inspecting Engineers, as Inspector of Metallic Materials; or would undertake such work by contract.—Address, H 51, Offices of ENGINEERING.

Heat Treatment and Harden- ING IN ALL PROCESSES.—Foreman OPEN for ENGAGEMENT, 16 years' practical experience.—Address, H 298, Offices of ENGINEERING.

Sales Ledger, Accounts Clerk, competent man (42), REQUIRES POSITION in London, accustomed to control large numbers of accounts, highest references.—HENRY T. MARSHALL, 40, Blandford Road, Beckenham. H 319

Cost Clerk (29), Desires CHANGE. With present employers, Engine Builders, nine years, sole charge. Salary £300-£350.—Address, H 324, Offices of ENGINEERING.

Experienced Young Lady REQUIRES POST as tracer. Aviation and ship drawing experience, also excellent testimonials.—Address, H 349, Offices of ENGINEERING.

Junior Structural Draughts- MAN DESIRES CHANGE, 12 months D.O. experience, University Engineering Diploma, excellent references.—Address, H 306, Offices of ENGINEERING.

Young Engineer, A.M.I.C.E., with University Degree and knowledge of French, DESIRES POST in London. Has had good experience in General Engineering and Export business.—Address, H 22, Offices of ENGINEERING.

Sheet Metal Worker Seeks BERTH, as Foreman or Charge Hand. Hons. Diploma City and Guilds, also I.C.S. Diploma. Sound practical experience with technical training, excellent references.—Address, H 390, Offices of ENGINEERING.

Engineer (29), A.M.I.C.E., B.Sc., unmarried, DESIRES progressive POSITION, as Technical Assistant. Works, d.e., and sales office experience, general engineering, conveying, and iron works plant.—Address, H 400, Offices of ENGINEERING.

PARTNERSHIPS.

IMMATURE PRESENTATION,
IGNORANT COMMENDATION,
INCAUTIOUS EXPEDITION,
all these you avoid
by consulting us as to

Engineering Partnerships and Businesses.

WHEATLEY KIRK, PRICE & CO.
Expert Valuers of Factories and Works,
48, Watling Street, London, E.C. 4.
8101
ESTABLISHED SEVENTY YEARS.

Having Taken Larger Offices in Queen Victoria Street, a Well-established Mechanical and Electrical Engineer, with valuable connection among high-class clients

SEEKS the CO-OPERATION of another ENGINEER

with good personal connections, with a view to undertaking new business at present untouched.

Separate office can be given with 'phone, attendance and typing. Lift.

Advertiser has had 20 years' experience, and can only entertain offers from a gentleman of position. Address, H 386, Offices of ENGINEERING.

PATENT AGENTS.

Jensen and Son 3079
CHARTERED PATENT AGENTS.
Established 1857. British, Colonial, and Foreign Patents, and Trade Marks and Designs Registration
77, Chancery Lane, London, W.C. Tel.: Holborn 1249

John E. Raworth & Moss, CHARTERED PATENT AGENTS.
75, Victoria Street, Westminster, S.W. 1. 8102

Patents, Inventions, Trade MARKS, DESIGNS.—Advice and handbook free.—KING'S PATENT AGENCY, LIMITED, 166, Queen Victoria Street, London. Over 34 years' references. Telephone: Central 682. 8098

S. Sokal, CHARTERED PATENT AGENT.
1, Great James Street, Bedford Row, London, W.C.1.
T. N. 4515 Holborn. 7905

WANTED, &c.

Electro-Mechanical Engineer, Sound, Practical, and Theoretical Training, also commercial experience, DESIRES AGENCY or represent engineering firm on N.E. Coast.—Address, H 367, Offices of ENGINEERING.

The Proprietors of the Patent No. 3498 of 1908 for "Improvements in Drills and Methods of Making the same," are DESIROUS of ENTERING into ARRANGEMENTS by way of Licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this Country.—All communications should be addressed in the first instance to, HASELTINE, LAKE & CO., Chartered Patent Agents, 26, Southampton Buildings, Chancery Lane, London, W.C. H 397

The Proprietor of British Patents Nos. 7163/14 and 7184/14, both dated March 31, 1914, pertaining to "Journal Bearings" and "Improvement in and Relating to Automatic Cross Feed Mechanism for Grinding Machines" respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patents and ensuring their practical workings in Great Britain.—All inquiries to be addressed to B. SINGER, 39, So. La Salle Street, Chicago, Illinois. H 276

The Proprietor of British Patent No. 103228, dated April 17, 1916, relating to "Improvement in Furnace," is DESIROUS of ENTERING into ARRANGEMENTS by way of license or otherwise, on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All enquiries to be addressed to B. SINGER, 39, So. La Salle Street, Chicago, Illinois. H 277

Electric Industrial Trucks.—The Owners of British Patent 13406/1914, covering an Electric Industrial Truck which has proved a success in America, are DESIROUS of MAKING LICENCE ARRANGEMENTS for the manufacture and commercial exploitation of the truck in this country. Full working drawings, bills of materials, specifications, catalogues, etc., will be supplied to Licensee.—Communications should be addressed to Messrs. GEORGE BARKER AND BRETTELL, Chartered Patent Agents and Consulting Engineers, 77, Colmore Row, Birmingham. H 300

The Proprietor of British Patent No. 26350 of 1912, for "Improvements in or relating to Boilers or Steam Generators," is DESIROUS of NEGOTIATING with interested parties, either for the Sale outright or for granting Licenses thereunder on reasonable terms.—Please address communications to Messrs. DICKER AND POLLAK, 20-23, Holborn, London, E.C. 1. H 380

The Proprietor of British Patent No. 21957 of 1913, for "Improvements in or relating to the Construction of Boilers or the like," is DESIROUS of NEGOTIATING with interested parties, either for the Sale outright or for granting Licenses thereunder on reasonable terms.—Please address communications to Messrs. DICKER AND POLLAK, 20-23, Holborn, London, E.C. 1. H 381

The Proprietor of British Patent No. 132236 of 1919, relating to "Means for Repairing Leaks in Metal Utensils," is DESIROUS of ENTERING into ARRANGEMENTS, by way of license or otherwise, on reasonable terms, with interested parties, for the purpose of working same in the United Kingdom.

For information apply to
G. H. KING,
92, Gt. Portland St., London, W. 1. H 362

Canadian Sales Engineer and Graduate of McGill University, Montreal, with eighteen years practical experience and business connection throughout Canada, DESIRES to secure the REPRESENTATION of British firms seeking this market on either salary or salary and commission basis.—Address reply, BOX 100 C.L.T., ENGINEERING INSTITUTE OF CANADA, Montreal, Canada. H 295

Demobbed Officer, with sound Engineering training extending over 16 years, SEEKS REPRESENTATION in Scotland where connection amongst Engineering firms would be of value.—BOX 30, MITCHELL'S Advertising Agency, 68, Gordon Street, Glasgow. H 326

CONTRACTS.

One of the Largest and Most Up-to-Date Plants in England HAVE AVAILABLE for Large Running Contracts about 1000 MACHINE TOOLS, comprising :—

Autos, Capstans, Chucking Autos, Centre Lathes, Grinders, Slotters, Planers, Millers and Gear Cutters. Fully equipped TOOL ROOM, FORGE and ASSEMBLY SHOPS.

ENGINE, GEAR BOXES, AXLES, PUMPS, MOTORS or SIMILAR INTERCHANGEABLE WORK REQUIRED in LARGE QUANTITIES.

COMMUNICATIONS are INVITED from Responsible Firms in confidence.

Address, H 198,
Offices of ENGINEERING.

Light Engineering.—Wanted a FIRM able to UNDERTAKE Immediate PRODUCTION of a few sample machines (Light Mechanisms). Estimates will be required—Blue Prints ready—Birmingham or Manchester districts preferred.—Address, H 321, Offices of ENGINEERING.

Wanted, &c., continued on page 154.

Thomas Hunt & Sons, Engineers and MILLWRIGHTS, of Albion Iron Works, Bridge Road West, Battersea, S.W. 11, undertake the MANUFACTURE of ALL CLASSES of MACHINERY. Prompt attention given to Repairs and Breakdowns. 8538

Before Ordering Drawing Office Furniture obtain prices from the actual manufacturers.—THE CAMDEN DRAWING OFFICE, Church Street, Leamington Spa. Suppliers of every Drawing Office requirement. G 710

Machine Work Wanted.—Turning, Boring (centre lathes), Grinding and Milling done to accurate limits. Complete Motor Engines, Gear Boxes, etc., or parts of same.—THE COMMERCIAL & MARINE ENGINE CO., LTD., Oak Works, Hanwell, W. 7. F 507

Drawings.—Mech. Engineers, with extensive general and hydraulic design experience, and 20 years' specialised design and production experience of I.C.E.'s, all types and sizes, with jigs and tools for same, can UNDERTAKE COMPLETE DESIGNS, Workings, Drawings and Tracings.—Address, 8578, Offices of ENGINEERING.

Planing and Boring Work WANTED, of a repetition character. Planing up to 30 in. by 8 ft. Accuracy guaranteed. Prompt deliveries. THE STRINGER TYPE MFG. CO., LTD., Ladbrook Road, South Norwood, London, S.E. 25. G 993

Drawings Prepared by First-class Mech. Draughtsmen Engineers, not Tracers. Complete drawings prepared from rough sketches. Jigs and Tools designed. WE SPECIALIZE IN BOILER MOUNTINGS. Stop Valves for all pressures, Reducing Valves, etc., designed on years of experience.—Address, H 52, Offices of ENGINEERING.

Drawings, Every Description GEN. ENG.:—Details, Tracings, Sketches, Blue Prints, etc. Accurately and confidentially undertaken in private d.o.—Address, H 329, Offices of ENGINEERING.

Agents Wanted in Industrial centres for Electric Locomotives. Only first-class firms need apply.—Address, H 363, Offices of ENGINEERING.

New Zealand.—Consulting Engineer and Marine Surveyor returning shortly, WOULD ACT as REPRESENTATIVE, take up an Engineering Equipment Agency, or carry out Engineering Commissions. Interview London.—Address, H 126, Offices of ENGINEERING.

Engineer.—Mechanical and Automobile, Consulting, Inspection, Work and Materials, Purchasing and Selling Advice, Technical Descriptive Writing of Brochures and Instruction Manuals. Advice on Patents. TECHNICAL REPRESENTATION of Engineering Firms REQUIRED for London and other districts.—H. G. LESTER, 89, Pembroke Crescent, Hove. H 236

A Time Recorder Wanted, State price and where can be seen.—BOX T.R., SMITH'S Advertising Agency, Ltd., 100, Fleet Street, London, E.C. 4. F 600

Wanted, One 30 ton Railway PLATFORM WEIGHBRIDGE, new or second hand.—Full particulars and lowest price, to G. A. HARVEY & CO. (LONDON), LTD., Greenwich Metal Works, Woolwich Road, S.E. 7. H 378

Wanted, in London District, THREE LANCASHIRE BOILERS, for a working pressure of not less than 80 lbs., dimensions 30 ft. by about 7 ft. 6 in. Must not be more than five years old. Offers should state maker's name, year of manufacture, and where boilers can be seen.—Write BOX 578, POTTER'S Advertising Agency, Imperial House, Kingsway, W.C. 2. H 134

Wanted, Second-hand Electric MOTOR, to give approximately 150 B.HP., and suitable for 500 volt, 3-phase, 50 cycle circuit.—Particulars and price to R. SILCOCK & SONS, 56, Great Howard Street, Liverpool. H 149

Wanted, LARGE WEEKLY SUPPLIES of Engines, Gear Boxes, Front and Rear Axles and other machined details for motor car construction to our designs, will place contracts covering three years' supply. —Manufacturers open for work, write BOX ENGINE, care of Advertisement Department, 5 New Bridge Street, London, E.C. 4. H 340

Wanted, Second-hand Smith, Barker & Willson LATHES, 8½ in. centre by 8 ft. or 10 ft. Beds. Must be in good condition.—ROSE, INNES, KAY & CO., 4, Fenchurch Avenue, London, E.C. 3. 8651

Wanted, Compound Steam ENGINE, condensing or non-condensing, vertical or horizontal, about 90 r.p.m., 120 to 150 HP., at 90 lbs. Must drive on right hand side looking from cylinders.—Address, with particulars, H 360, Offices of ENGINEERING.

Wanted, Four Lancashire BOILERS complete, preferably 8 ft. diameter 28 ft. long, suitable reinsure 180 lbs. steam pressure. Write BOX 67, SELLS Advertising Offices, Fleet St., E.C. H 18

Required Immediately, Second-hand BLISS PRESS, No. 3½ Double Action; or similar capacity by other Maker. Must be in unquestionably good condition.—Letters to STERLING TELEPHONE & ELECTRIC CO., LTD., Dagenham, Essex. H 388

Wanted, Steam Derrick CRANES, 10-25 Tons. Jibs about 60 ft. Full particulars, lowest price and where to be seen. —Address, H 3 1, Offices of ENGINEERING.

Wanted, an Electric Crane, New or Second-hand, to lift seven tons, power 220 volts, D.C. Span 43 ft. 3 in. State price and how soon you could deliver.—Address, R. S., c/o BIRCHALL'S Advertising Offices, Liverpool. H 282

Wanted, One Second-hand LOCO. TURNTABLE, 30 to 35 ft., capable of supporting a load of from 40 to 45 tons.—Address, H 399, Offices of ENGINEERING.

Wanted, Turbo Generator (mixed or low pressure) 550 volt D.C. any power 250 to 700 Kw. complete with condenser. Please quote make of turbine, generator and condenser, date of manufacture, send print and full particulars.—EDWARDS & SHAW, Consulting Engineers, 105, Colmore Row, Birmingham. H 294

Wanted, Saddle Tank Loco., four wheel coupled, 13 in. by 20 in., 150 lbs. pressure, weight about 20 tons.—Full details to THE MIDLAND MACHINERY CO., 108, Dale End, Birmingham. H 348

Wanted, to Purchase 45 to 50 Tons ELECTRIC CRANE with overhang of about 40 ft. New or second-hand. Send full particulars and drawings and quote lowest price and where seen.

PITCHERS, LTD.,
North Quay, Gt. Yarmouth. H 352

Wanted, to Rent or Purchase SMALL ENGINEERING WORKS in London or Suburbs.—Reply with full particulars to G.S.C., 26, Martin Lane, Cannon Street, E.C. 4. H 403

Wanted, Light Railway Plant. Several miles of Track, 24 in. or 30 in. gauge, flange Rail, 20-25 lbs. per yard (with Fishplates, Bolts, Spikes, Steel or Wood Sleepers), Bogies for carrying timber, also two or three Petrol Tractors or Steam Locomotives. Also several miles of Track, 1 meter gauge, 40, 45, or 50 lbs. per yard (with Fishplates, Bolts, Spikes), 30 Bogie Frames (Ironwork only), three Locomotives, 0-6-0 type, with Tenders attached, or three to Petrol Tractors.

BUTE WORKS SUPPLY CO., LTD.,
8, Cymric Buildings, Cardiff. H 396

AUCTION SALES.

PRELIMINARY ADVERTISEMENT.

GLOUCESTER.

Bruton, Knowles & Co. are instructed by J. H. BAKER, Esq., the Receiver for the Debenture Holders, to SELL BY AUCTION, on FRIDAY, JULY 30TH, 1920—the Important

FREEHOLD FACTORY PREMISES,

at present occupied by the British Carbonising Co., Ltd., and comprising extensive and Up-to-date FACTORY PREMISES, with concrete floors throughout, situated in Quay Street, Gloucester, with VACANT POSSESSION ON COMPLETION OF THE PURCHASE. And also adjoining PREMISES, suitable for a smaller factory.

THE VALUABLE MACHINERY AND PLANT

Will be Offered for Sale on the same day.

Further particulars may shortly be had of A. LIONEL LANE, Esq., Solicitor; Messrs. DUART-SMITH, BAKER & PRICE, Accountants; or of the AUCTIONEERS, all of Gloucester. H 414

G R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD
(PLANT AND MACHINERY SECTION).

Sale by Auction of

EXCELLENT MODERN HIGH CLASS MACHINE TOOLS

At (A. V. ROE & CO., LTD.) PARK WORKS, TEN ACRES LANE, NEWTON HEATH, MANCHESTER,

On WEDNESDAY and THURSDAY, JULY 7TH and 8TH, at Eleven o'clock prompt.

Comprising:—

THE EXCELLENT MODERN, HIGH-CLASS MACHINE TOOLS.

Six 24 in. Bullard Vertical Boring and Turning Lathes, six Becker No. 4B Vertical Milling Machines, eight 26 in. Swing Chucking Lathes, by The Colchester Lathe Co., three 24 in. Swing Ditto, by George Swift & Co., Halifax, six 8 in. Oliver Centre Screw Cutting Lathes on 7 ft. V type bed, two Warner & Swasey No. 2A Universal Hollow Hexagon Turret Lathes, one No. 4 Ditto, one Bardons & Oliver 9½ in. Centre Turret Lathe, one Le Blond 6½ in. Centre Heavy Duty Screw Cutting Lathe, one Le Blond 7 in. Centre Ditto, one Simplex 8 in. Centre Ditto, one South Bend 6 in. Centre Ditto, one Robson 12½ in. Centre Ditto, one Robson 12½ in. Centre Ditto on 12 ft. Gap Bed, one Lumsden No. 1 Oscillating Tool Grinder, one Landis 6 in.-18 in. Plain Grinder, two Modern 12 in. by 48 in. Ditto, seven Heald No. 60 Cylinder Grinders, one Heald 8 in. Ring and Surface Grinder, five Norton Spindle Bench Grinders, one Richards No. 1 Automatic Slot Drilling Machine, one Heaps Horizontal Duplex Ditto, one 4 Spindle High Speed Sensitive Drilling Machine, two Cosens High Speed Drilling Machine, two Standard Ditto, one Kearns No. 1 Horizontal Boring and Facing Machine, two Cylinder Balancing Machines, one Brayshaw Carbonising Gas Furnace, 18 in. by 9 in. by 24 in., one Brayshaw No. 1 High Speed Tool Furnace.

The following Machines are the Property of Messrs. A. V. Roe & Co., Ltd.:—Two ¾ in. Cleveland Automatic Machines, one ½ in. Ditto, one ¾ in. Ditto, one ⅝ in. Ditto, one 1¼ in. Centaur Capstan Lathe, one ¾ in. Ditto, one 1 in. Garvin Ditto, one 1 in. Dreesia Ditto, one 1 in. Brown & Sharpe Ditto, one 1 in. Pratt & Whitney Ditto, one 1 in. Foster Kimball Ditto, seven 1 in. Caltonia Ditto, one ¾ in. Allens Ditto, one Hand Lever Punching Machine, one Horizontal Rattle Box, three Jackman Cone Shaped Tumbling Barrels, two Small Assembling Machines, one Dowight Marking Machine, two Tap Grooving Machines, one Patent Twist Drill Grooving Machine, one Sand Papering Machine, one Vertical Wood Boring Machine, one Circular Saw Bench, one Rhodes Power Press, seven Various Hand Presses, six Various Foot Presses, three 30 in. Electric Air Propellers, two 18 in. Ditto, two 12 in. Ditto, two 50 in. Belt Driven Air Propellers, four 40 in. Ditto, one 30 in. Ditto, one 24 in. Ditto, one 36 in. Electric High Pressure Blower, by Keith Blackman & Co., Ltd., Various Electric Fittings, Large Quantity Bright Screwed Bolts, 5 Tons Bright Steel Wire, 25 Cwts. Oval Steel Tubes, 4 Tons Neck Stranded Steel Cable, Nos. 5, 6, 8, 10 and 14 S.W.G., 65 Parallel Vices, 10 Tail Vices, 24 doz. Joiners' Iron Cramps, 13 doz. Wood Ditto, 100 Small Iron Jigs, four Musgrave's Patent Combustion Stoves, seven Gas Heat Radiators, New 20 Ton Railway Wagon Weighbridge, by H. Pooley & Son, Ltd., Iron Book Safe Engine Lathes, one Milwaukee 10½ in. Centre Screw Cutting Engine Lathe, two Selson 10 in. Ditto, three Cisco 10 in. Ditto, one Selson 9½ in. Ditto, one Monarch 9 in. Ditto, two Prentice 9 in. Ditto, one Barnes 9 in. Ditto, one Le Blond 8½ in. Ditto, seven Oliver 8 in. Ditto, two Fay & Scott 7 in. Ditto, nine Phillip Smith 6½ in. Ditto, four Precisions 6 in. Ditto, two Selsons 5 in. Ditto, one Warner & Swasey No. 2A Universal Hollow Hexagon Turret Lathe, two Selsons' 7 in. Centre Capstan Lathes, two Senecs 6½ in. Centre Slide Lathes, one 7½ in. Centre Heavy Duty Slide Lathe, one Landis No. 1½ in. Circular Grinder, one 3 wheel Grinding and Glazing Machine, one Heavy Type Slotting Machine, 15 in. max. stroke, two Fox Light Type Milling Machines, Excellent Electrical Copper Depositing Plant, with 6-1000 amp. Dynamo, 2-1000 amp. Ditto, 40 HP. Motor, 49 Lead Lined Vats, 36 cwt. Copper Amodes, 1300 ft. Solid Copper Bus Bars, and fittings, by Canning & Co., Birmingham.

NOTE.—This Electrical Copper Depositing Plant is at the Works of Crossley Motors, Ltd., Gorton Lane, Gorton, Manchester, and can only be inspected by permit to be obtained from the Auctioneers.

On View during working hours one week prior to Sale on production of catalogue. Sale to commence each day at Eleven a.m.

Catalogues may be had from the Auctioneers, Messrs.

EDWARD RUSHTON, SON & KENYON,
13, Norfolk Street, Manchester.
Telephone No.—775 and 5633 City.

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d., at all bookstalls, or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. H 238

At the Engineering Works of Messrs. LYON AND WRENCH, VICTORIA ROAD, WILLESDEN JUNCTION, N.W., Messrs.

Fuller, Horsey, Sons & Cassell will SELL by AUCTION in lots on the PREMISES, on Tuesday, JULY 27th, and following days, at Eleven o'clock each day.

HIGH CLASS MACHINE TOOLS,
including:—

Five No. 4 Herbert's Auto CAPSTAN LATHES with Bar and Chucking equipment.
A No. 9 and a No. 3 Herbert's COMBINATION TURRET LATHE.
Eighteen CAPSTAN LATHES, various, by Warner & Swasey, Pratt & Whitney, Bradbury, Wards, and Garvin from ¾ in. by 3 in. to 2 in. by 6 in.
Twenty-seven SLIDE, SURFACING and SCREW CUTTING LATHES from 4 in. to 9 in. centres and beds 3 ft. to 12 ft. long, by American Tool Works, Bradford, Seneca Falls, Barnes, &c.
Thirty-three HAND and BENCH LATHES, various.
Four No. 1½ CINCINNATI UNIVERSAL & PLAIN MILLING MACHINES.
Two No. 00 STEPTOE MILLING MACHINES.
Seven PLAIN MILLING MACHINES by Garvin, Herberts, Wards, Loewe, Heckford, &c.
A No. 2 BECKER VERTICAL MILLING MACHINE.
Two GEAR CUTTING MACHINES by Schuchart & Schutte.
A Webster & Bennett 18 in. DUPLEX VERTICAL BORING MILL.
A Kearns HORIZONTAL BORING MACHINE with 5 ft. table.
A 3 ft. RADIAL DRILLING & TAPPING MACHINE by the American Tool Works Company.
Twenty-six Multi and Single Spindle VERTICAL DRILLING MACHINES, various.
Four Vertical AUTO TAPPING MACHINES.
A Redman PLANING MACHINE. 6 ft. by 2 ft. by 2 ft.
A 10 in. by 24 in. Churchill UNIVERSAL TOOL GRINDER.
A 10 in. by 36 in. PLAIN Ditto by same makers.
A No. 3 Brown & Sharpe's pattern SURFACE GRINDING MACHINE.
A No. 1 Le Blond TOOL and CUTTER GRINDER.
Two Globe and eight TOOL and CUTTER GRINDERS, various.
A 14 in. Hendey SHAPING MACHINE and two Bench Ditto.
A 6 in. Archdale SLOTTING MACHINE and a 3 in. Ditto by Clarke's Machine Tool Co.
Four HACK SAW MACHINES.
A 50 ton POWER PRESS by Rhodes & Co.
A No. 20 Bliss INCLINABLE POWER PRESS.
Fourteen POWER and HAND PRESSES.
An ENGRAVING MACHINE by Taylor, Taylor & Hobson.
Two Tinman's GUILLOTINE SHEARS and 9 rolling, folding and bending machines.

WOODWORKING MACHINERY,

Comprising Watkins General Joiner, Disc Sand Papering Machine, Chain and Hand Mortising Machines, two Circular Saw Benches and a Band Saw Machine.
Also a large assortment of
ENGINEERS STORES and SMALL TOOLS
15 tons Brass Rods and Bars, 30 cwt. Avery Portable Weighing Machine, Office Furniture and other effects.
May be viewed and Catalogues had of Messrs. FULLER, HORSEY & CO., Mechanical Auctioneers and Valuers, 11, Billiter Square, E.C. 3. H 361

G R.

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD.
(PLANT AND MACHINERY SECTION.)

Important Two Days' Sale of MACHINE TOOLS, PLANT AND ELECTRICAL EQUIPMENT,

At the ROYAL NAVAL GUN FACTORY, WESTHOUGHTON, LANCASHIRE.

On WEDNESDAY and THURSDAY, JULY 21st and 22nd, Commencing at TWELVE Noon each day promptly. Including:—

33 LATHES, S.S. & S.C. Wire coiling, boring and others, 3 5/8 in. centres up to 24 in. centres, by leading makers.
29 MILLING MACHINES, Vertical, Special, thread and Profile, by Herbert & Co., Ltd., and others.
FOUR MILLING & PROFILING MACHINES.
THREE PORTABLE "DUNTLEY" ELECTRIC DRILLING MACHINES, ¾ in. and ½ in. capacity, by the Consolidated Pneumatic Tool Co., Ltd.
NINE DRILLING MACHINES, Horizontal, Vertical, sensitive, drilling, and tapping and rifle barrels, by J. Holroyd & Co., and others.
TWO SHAPING MACHINES, 8 in. and 12 in. stroke.
NINE SLOTTING MACHINES, 20 in. to 24 in. stroke, by Hulse & Co., and others.
SEVEN PLANING MACHINES to Admit from 2 ft. 6 in. to 4 ft.
13 GRINDING MACHINES, universal, surface, plain, external and others, by J. Holroyd & Co., and C. Churchill & Co., Ltd.
12 HACK SAWING MACHINES, various, by B. G. Herbert, Ltd., and others.
THREE RIFLING MACHINES for 3 in., 4 in., 6 in., and 6 Pdr. Naval Guns.
16 SINGLE-ENDED GUN FINISHING BORING MACHINES.
THREE DOUBLE-ENDED GUN ROUGH BORING MACHINES.
FOUR GUN BORING MACHINES, 25 in. centre.
TWO HORIZONTAL, TWO SPINDLE DRAW BORING MACHINES, for Rifle Barrels.
TWO RIFLE BARREL REAMING MACHINES.
TWO RIFLE BARREL RIFLING MACHINES.
FOUR LAPPING MACHINES for 4 in. and 6 in. bore guns and rifle barrels.
THREE BENCH SCREWING ATTACHMENTS for Thread Cutting.
10 GRINDSTONES with Stones from 30 in. by 4 in. up to 60 in. by 10 in. by Alldays & Onions, and others.
TWO BLOWING FANS by Alldays & Onions.
ONE "BURMKA" METAL JIG SAWING MACHINE, by Thomson & Co., U.S.A.
ONE BAND SAWING MACHINE, No. 38 Sager.
ONE PLANING MACHINE for Woodworking, No. 7 Sager.
TWO BROACHING MACHINES by Lapointe & Co., U.S.A.
FOUR REVOLVING STAYS for Planing Naval Gun Jackets.
TWO GUARD CRANE LADLES 20 cwts. and 40 cwts.
100 BORING BARS from 2 in. up to 6 in. diameter, various lengths.
SIX TONS CAST IRON WALL BRACKETS and HANGERS.
ONE FIVE TON ELECTRICALLY DRIVEN FORGE CRANE, working radius 6 ft. 3 in. to 16 ft., height of lift 13 ft., by Thwaites Bros., Ltd., Bradford.
TWO 7 in. HIGH LIFT ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS to deliver 450 Gallons per minute by Worthington Ltd.
THREE 4 in. LOW LIFT ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS by Worthington Ltd.
ONE G.C. 3 TYPE "A" GAS COMPRESSOR by Alldays and Onions, Ltd.
TWO CENTRIFUGAL OIL SEPARATORS by Manlove & Elliott.
ONE MAGNETIC SEPARATOR by Phillips, Ltd.
ONE SAND AND LOAM MILL by Phillips, Ltd.
ONE 1000 TON HYDRAULIC STRAIGHTENING PRESS Complete with Pumps by Davy Bros.
ONE ELECTRICALLY DRIVEN STAMPING PLANT consisting of Two Batteries of drop stamps, Five oil fired furnaces, Five coke fired furnaces, One oil fired annealing furnace, One coke fired annealing furnace, one "Roots" Acme Blower, Two Double-Throw Feed Pumps, Two Storage Tanks, and No. 6 size Trimming Press with the following Motors: One 50 HP. Motor and Starter, Two 15 HP. Motors and Starters, and One 3 HP. Motor and Starter
ONE GAS PRODUCER PLANT consisting of Tempering and 4 muffle Furnaces and Tanks for 4 in. and 6 in. guns, "Duff" Gas Producer Plant, Three Units, Gas Main, Flues and Two Chimneys, 25 N.P. Vertical Boiler and Motor driven Air Fan, by the Dowson & Mason Gas Plant Co., Ltd.
ONE CUPOLA PLANT consisting of Two Cupolas, "Roots" Motor driven Blower, charging Platform and jib swing crane and fittings, by Jas. Evans, & Co., Ltd.
ONE 200 K.W. ROTARY CONVERTER SET consisting of Rotary Converter and Transformer, Four Meters and D.C. Slate Panel and Fittings, by The Lancashire Electric Power Co. Ltd.
ONE GAS OVEN SEMI-MUFFLE FURNACE No. 1 with No. 4 Rotary Pressure Blower, by C. Churchill & Co., Ltd.
ONE OIL FIRED REVERBERATORY TYPE FURNACE complete, by C. Churchill & Co., Ltd.
35 D.C. ELECTRIC MOTORS, ¼ HP. to 25 HP. by Electrometers, Laurence & Scott, and others
2156 lbs. of SINGLH LEATHER BELTING.
476 lbs. of DOUBLE LEATHER BELTING.
47 lbs. of BALATA BELTING.
Admission by Catalogue only, Price 1/- each.
On View One Week prior to date of Sale.

Catalogues may be had from the Auctioneers,
SALISBURY & HAMER, F.A.I.
Borough Chambers, 54, Church Street, Blackburn, (T. N. 3081) and 7, Pall Mall, Manchester (T. N. 560, City).

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d., at all bookstalls; or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. H 207

Wheatley, Kirk, Price & Co.
(Established 1856).

Auctioneers
AND VALUERS OF 2191
ENGINEERING WORKS PLANT AND STOCK
66, WATLING STREET, LONDON, E.C.
16, ALBERT SQ., 26, COLLINGWOOD ST.,
MANCHESTER. NEWCASTLE-ON-TYNE.
Telephones & Telegrams at each Address.

SECOND PORTION OF SALE.

CHESTON ROAD, ASTON, BIRMINGHAM

By direction of the ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD.

IMPORTANT SALE OF SURPLUS MACHINE TOOLS, SMALL TOOLS, &c., including
12 Screwcutting and Turning Lathes.
Nine Capstan Lathes.
30 in. Archdale Radial Drill.
22 Drilling Machines, 1 to 4 spindle.
Heavy Tangye Face Milling Machine with motor.
Five other Milling Machines.
One Plano-Milling Machine, by H. W. Ward, to take 7 ft. by 4 ft. 6 in., with motor.
10 Disc and other Grinders.
Heavy 60 in. Boring Mill, by Hulse.
24 in. Cold Saw, by Craven, with motor.
24 Sets Chain Blocks, 5 cwt. to 3 tons.
1 Ton Walking Crane.
Two Loco. type Boilers.
Four Ideal low pressure Steam Heating Boilers and one low pressure Water Boiler.
Five Lacquering Tables.
Seven Oil Cabinets and Filter.
TWO HEAVY SLOTTED TESTING TABLES.
About 30,000 ft. of LEATHER BELTING, varying 1 in. to 8 in. wide.
25 Sets of COMPUTING SCALES AND BALANCES.
Two Platform Weighing Machines, by Avery.
Large Assortment of Carborundum and Alundum Grinding Wheels. About 30,000 New TWIST DRILLS from No. 1 to 2 in., and quantity of Steel Limit Gauges, Ground Mandrils, Milling Cutters and Saws, Reamers, Lathe Chucks, Machine and Hand Taps, Two Coventry Die Heads, ½ in. and 2 in., Whitworth and standard Chasers, and General Small Tools and Utensils.

Edwards Son & Bigwood
will SELL by AUCTION on the Premises as above, on TUESDAY and WEDNESDAY, JUNE 29TH and 30TH, 1920, commencing at Eleven o'clock prompt each day.
On View Monday, June 28th, from Ten till Four.
Catalogues may be had of the AUCTIONEERS, 158, Edmund Street, Birmingham, and 94, High Street, Bromsgrove. H 65

G R

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD
(PLANT AND MACHINERY SECTION).

Four Days Sale of
VALUABLE PLANT AND MACHINERY,
At the NATIONAL ORDNANCE FACTORY (No. 2), HUNSLET, LEEDS,
On TUESDAY, WEDNESDAY, THURSDAY and FRIDAY, 13th, 14th, 15th and 16th JULY, At ELEVEN a.m. daily.
Comprising:—
LATHES.
Seven 10½ in. Centres, S. and S., 10 ft. Beds, by Harwaukee.
Three 13 in. Centres, S.S. and S.C., on 10 ft. Beds, by Pittsburg.
One 9½ in. Centre, S.S. and S.C., on 8 ft. Bed, by Le Blonde.
Six 15 in. Centres, S.S. and S.C., on 14 ft. Beds, by J. Lang & Sons.
14 12 in. Centres, S.S. and S.C., on 15 ft. Beds, by Dean, Smith & Grace.
12 12 in. Centres, S.S. and S.C., on 15 ft. Beds, by Tangye.
One 12 in. Centre, S.S. and S.C., on 34 ft. Bed, by Dean, Smith & Grace.
One 19 in. Centre, S.S. and S.C., on 13 ft. Bed, by Broadbent.
One 18 in. Centre, S.S. and S.C., on 17 ft. Bed, by Broadbent.
Two 12 in. Centres, S.S. and S.C., on 16 ft. Beds, by Dickinson.
Two 9 in. Centres, S.S. and S.C., on 8 ft. Beds, by Libby.
43 15 in. Centres, S. and S., on 14 ft. Beds, by J. Lang & Sons.
12 16 in. Centres, S. and S., on 15 ft. Beds, with Extension Beds 14 ft. long, by Gidden & Lewis.
65 12 in. Centres, S. and S., on 14 ft. 6 in. Beds, by J. Stirk & Son.
12 16 in. Centres, S. and S., on 26 ft. Beds, by J. Stirk & Son.
Five 18 in Centres, S. and S., on 24 ft. Beds, by Blackstone.
Two No. 4 Capstan Lathes, by A. Herberts.
20 12½ in. Centres Boring, on 27 ft. Beds, by Oldfield & Schofield.
Three 7 in. Centres Rifling Machines, on 25 ft. Beds, by Kendall & Gent.
Five 18 in. Centres ditto, on 42 ft. Beds, by Walmsley.
Four 16 in. Centres ditto, on 33 ft. Beds, by Mather & Platt.
Two 18 in. Centres ditto, on 40 ft. Beds, by Armstrong & Whitworth.
Four 13 in. Centres ditto, on 42 ft. Beds, by Haigh.
Six 22 in. Centres Wire Winding, on 24 ft. Beds, by J. Stirk & Son.
And other Lathes by Dempster Moore, Parkinson, Swift, Bridgeford & Co., Smith & Coventry, Selson and Birmingham.
Ten 13 in. Centres Lapping Machines, on 25 ft. Beds, by J. Stirk & Son.
Two 15½ in. Centres ditto, on 40 ft. Beds, by T. White & Sons.
Large number of three and four-jaw Independent Chucks, from 24 in. to 3 in. dia.

PLANING MACHINES.
Two 10 ft. by 5 ft. by 5 ft., by J. Buckton & Son.
10 16 ft. by 5 ft. by 5 ft., by J. Stirk & Son.
Two 10 ft. by 3 ft. by 3 ft., by J. Buckton & Son.
Four 10 ft. by 3 ft. 6 in. by 2 ft. 6 in., by J. Whiteley & Son.
One 14 ft. by 4 ft. by 4 ft., by G. Butler.
One 12 ft. by 4 ft. by 4 ft., by Smith & Coventry.
One 8 ft. by 3 ft. 6 in. by 3 ft., by J. Buckton & Son.
One 6 ft. 8 in. by 2 ft. 6 in. by 2 ft. 6 in., by Greenwood & Batley.
Four SHAPING MACHINES, 30 in. and 24 in. and 16 in. strokes, by Selson.
Three Vertical MILLING MACHINES, 40 in. (Heavy Type), 24 in. and 12 in. Circular Tables, by Becker.
One Universal MILLING MACHINE, 48 in. by 9½ in. Table, by Parkinson.
One Universal MILLING MACHINE, 46 in. by 8½ in. Table, by Cincinnati.
One Universal MILLING MACHINE, 48 in. by 8½ in. Table, by Kempsmith.
One Plain MILLING MACHINE, 60 in. by 16 in. Table, by Becker.
One Plain MILLING MACHINE, 42 in. by 12 in. Table, by A. Herberts.
One Plain MILLING MACHINE, 20 in. by 4 in. Table, by Fox.
One Plain MILLING MACHINE, 78 in. by 14 in. Table, by J. Buckton & Son.
One SPUR and WORM WHEEL GEAR CUTTING MACHINE, 22 in. Circular Table, by Wallwork.
One 18 in. stroke Geared SLOTTING MACHINE, 32 in. Circular Table, by G. Butler & Co.
One 10 in. stroke Geared SLOTTING MACHINE, 20 in. Circular Table, by Hudson & Jackson.
Two Central Thrust, 5 ft. 6 in. Radial DRILLING MACHINES, by Asquith.
Four 4 ft. 6 in. Radial DRILLING MACHINES, by Asquith.
One 3 ft. 6 in. Radial DRILLING MACHINE, by Muir.
One 2 ft. 6 in. Radial DRILLING MACHINE, by Archdale.
One 4 ft. Radial DRILLING MACHINE, by Greenwood & Batley.
Pillar DRILLING MACHINE, by Firbank and Jones & Shipman.
Six Sensitive DRILLING MACHINES, by Pollard and Layland and Clifford.
Two No. 2 OSCILLATING CUP WHEEL GRINDING MACHINES, by Lumsden.
Six Plain GRINDING MACHINES, by Lumsden.
Two Universal GRINDERS, 5 ft. 6 in. by 6½ in. Table and 4 ft. 8 in. by 9 in. Table, by Landis and Brown & Sharp.
One Universal GRINDER, by Norton.
One TWIST DRILL GRINDER, by Washburn and Co.
One SURFACE GRINDER, by The American Tool Co.
One Plain CUTTER GRINDER, by Oldroud.
One Double DISC GRINDER, by Selson.
Two SCREWING MACHINES, to 2½ in. by Heaps & Co. and Chadwin.
Three HACK SAW MACHINES, by Churchill and Selson.
One Nearly New Horizontal BORING, DRILLING and TAPPING MACHINE, by Dickinson.
One BAND SAW MACHINE, by Noble & Lund.
One PUNCHING and SHEARING MACHINE, by Gittus.
Two 200 Ton Pressure HYDRAULIC PRESSES, by Hawthorn, Davy.
One HYDRAULIC STRAIGHTENING PRESS, by Stewart.
HYDRAULIC ACCUMULATOR, 12 in. ram, 15 ft. stroke, Casing 10 ft. dia. to 1500 lbs. working pressure.
Set of Three-throw HYDRAULIC PUMPS, rams 3½ in. dia., 12 in. stroke, 60 revs., by Barclay.
Two Air Pressure Acme BLOWERS, by Thwaites.
Seven Rotary DRUM PUMPS.
57 10 cwt. HAND TRAVELLING CRANES, 12 ft. to 16 ft. Spans, by Vaughan.
Six 15 cwt. HAND TRAVELLING CRANES, 15 ft. to 23 ft. Spans, by Vaughan.
13 20 cwt. HAND TRAVELLING CRANES, 24 ft. to 35 ft. Spans, by Vaughan.
6000 ft. of 6 in. by 4 in. Steel Rolled JOISTS, for Crane Tracks.
Three 15 cwt. WALL JIB CRANES, by Morris.
Two 20 cwt. ELECTRIC LIFTS.
Five 2 ton ELECTRIC TRAVELLING CRANES, 35 ft. Spans, by Morris and Isles.
Five 30 cwt. ELECTRIC AUTOMATIC TRUCKS, by Adison.
One 40 cwt. ELECTRIC AUTOMATIC TRACTOR, by Lansing, and Generating Set.

201 ELECTRIC MOTORS.
One 75 B.HP., A.C., by The G.E.C.
12 50 B.HP., A.C., by J. Holmes & Co.
23 25 B.HP., A.C., by J. Holmes & Co.
37 1½ B.HP., D.C., by The Lancashire Dynamo Co., and Phœnix Co.
75 10 B.HP., A.C., by J. Holmes & Co.
16 5 B.HP., by Phœnix Company, Bradford.
27 3 B.HP., A.C., by The G.E.C.
Three 2 B.HP., A.C., by The British Westinghouse.
Seven 1½ B.HP., A.C., by Phœnix Co.; and Starters for same.
20 miles various size CABLE, from three-bore armoured to V.R. 3/20.
3400 ft. of 3½ in., 3 in. and 2½ in. Mild Steel Turned SHAFTING, by Croft and Co.
108 Pairs of FLANGED COUPLINGS.
270 Swivel Ring Oil Bearing PLUMMER BLOCKS.
200 C.I. FLOOR STANDS.
350 W.I. SPLIT PULLEYS.
15,000 ft. of Hoppletheweite, Gripoly.
SAND BLAST MACHINE.
3-cwt. PNEUMATIC HAMMER, by Massey.

WOODWORKING MACHINERY.
Band Saw Machine, Circular Saw Machine, Surface Planing Machine, Mortising Machine, Fox's Wood Trimmer, Wood-Turning Lathe, Joiners' Benches, and Quantity Dry TIMBER, PATTERNS, &c.
Large Quantity of W.I. and Hydraulic PIPING.

On VIEW, Wednesday, Thursday, Friday, Saturday and Monday, July 7, 8, 9, 10 and 12, from Ten to Five o'clock.
Catalogues 2s. each, on application to the Auctioneers—
RADON & LOCKWOOD,
84, James Street, Sheffield.
Admission by Catalogue only.
Telegrams: "Weedon," Sheffield.
Telephone: Central 111.

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d., at all bookstalls; or by quarterly subscription of 2s., post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W.1. H 61

63-64, WEAMAN STREET, BIRMINGHAM.

By direction of MESSRS. VICKERS LTD.

IMPORTANT CLEAR OUT SALE of VALUABLE MACHINERY and PLANT, including
VERY MASSIVE HORIZONTAL GEARED POWER PRESS, with three-throw crankshaft, 18 in. dia. by Greenwood & Batley.
TWO HEAVY VERTICAL GEARED POWER DRAWING PRESSES, with double rack driven Rams, by John Hands & Sons.
THREE SMALLER DITTO (two No. 2 and one No. 4) by Hands, 1915.
THREE 6½ in. CAPSTAN LATHES, by H. W. Ward.
One 6½ in. Hollow Spindle, double head Lathe, by H. W. Ward.
11 Hollow Spindle Cutting Off and other Lathes.
Four Thread Millers.
Two Drop Stamps.
Belt driven Horizontal Heading Machine, by Archdale.
Two Rotary Annealing Furnaces.
POWERFUL HORIZONTAL DRAWING MACHINE, by Taylor & Challen.
LONG LINES of SHAFTING, 4 in. dia. and smaller, with pulleys and fittings.
Two Fairs large Iron Cased Muffles.
Hand and Power lifts.
Lead lined and wood Pickle Boshes and Vats.
Quantity Drawing Tools, Vices, Wood Benching, and miscellaneous effects.

Edwards Son & Bigwood will
SELL by AUCTION on the Premises as above, on THURSDAY, JULY 1st, 1920, at Eleven o'clock prompt.
On view day previous to sale from Ten a.m. till Four p.m.
Catalogues may be had of the AUCTIONEERS, 158, Edmund Street, Birmingham, and 94, High Street, Bromsgrove. H 64

G R

MINISTRY OF MUNITIONS.

BY DIRECTION OF THE DISPOSAL BOARD
(PLANT AND MACHINERY SECTION.)

IMPORTANT SALE OF ENGINEERS' MACHINE TOOLS, PLANT AND MACHINERY, ELECTRICAL EQUIPMENT, RAILWAY PLANT, AND STORES,
At the G.S.D. DEPOT, 1605, NEWBURY, BERKS,
Adjacent to the G.W.R. Station,
On TUESDAY, 29th JUNE, and TWO FOLLOWING DAYS,
At ELEVEN a.m. Daily,
Comprising:—
MACHINE TOOLS.
60 Lathes, S.A., S.S., S.C., Capstan and Turning, by leading makers. 20 Drilling Machines, Copper Depositing Plant, Sand Blasting Apparatus, Planing Machines, a 7-ton Derrick Crane, Grinding and Milling Machines. Log Frame Saw.
AGRICULTURAL MACHINERY.
Ten Hydraulic Testing Machines by Armstrong Whitworth and East Ferry Co. 800 sets Chaser Dies, Punching and Shearing Machine. 25 Oil and Steam Engines.
GENERAL PLANT AND MACHINERY.
Warehouse Trucks, 30 Beam Scales, Oval and Straight Runways, 25 Chain Blocks and Travellers, Hydraulic Accumulator, 1500 lb. Pressure, Electric Motors, 50 h.p. to 1 h.p.; 15 Saw Benches.
RAILWAY PLANT.
Ten LOCOMOTIVES (nine 2 ft. gauge, one 2 ft. 6 in. gauge), TRAUK and RAILS, (from 12 lb. to 55 lb.), 4000 WOOD SLEEPERS, Side Tip and Platform Bogies, Steam Navvy by Ruston-Proctor.
ELECTRICAL STORES & MATERIALS.
200 miles Cable and Wire, Telephone and Telegraph Appliances, 8000 Lamp Bulbs, Dynamometer for testing 800-1200 B.H.P.
CANTEEN EQUIPMENT AND FURNITURE.
On View, 22nd to 25th June.
Admission by Catalogue, price 1s, which may be had of the Auctioneers,

Dreweatt, Watson & Barton,
NEWBURY.

NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d., at all bookstalls; or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W.1. H 217

G R

MINISTRY OF MUNITIONS.
BY DIRECTION OF THE DISPOSAL BOARD
(HUTS AND BUILDING MATERIALS SECTION).
GEORGETOWN STATION.
At THE R.A.O. DEPOT, GEORGETOWN
(Via Caledonian Railway).
On TUESDAY next, 29th JUNE, commencing at Eleven o'clock.
HIGHLY IMPORTANT PUBLIC SALE OF VALUABLE TIMBER and RAILWAY MATERIALS, CORRUGATED IRON, WATERPROOF ASBESTOS SHEETING.

Matthew Marshall has been
instructed to SELL by AUCTION, as above.
The Materials include:—
GEORGETOWN RAILWAY STATION.
Comprising TWO PLATFORMS, 634 feet and 630 feet long, built of 3 in. Timber, TWO SHELTERS, 510 feet and 267 feet long, covered with Waterproof Asbestos Sheeting, COVERED FOOT-BRIDGE OVER RAILWAY, 320 feet long, built of Timber and Corrugated Iron Sheeting. TWO OFFICES, 36 ft. by 7 ft. by 7 ft. and 51 ft. by 9 ft. by 9 ft. And other Items. THREE RAILWAY SIDINGS, comprising 1310 YARDS OF RAIL, with SLEEPERS, CHAIRS, &c.
Catalogues giving full particulars, may be had at the AUCTIONEER'S Offices, 72, Waterloo Street, Glasgow. Telephone Central 2885.
On View on MONDAY, 28TH JUNE, from 10 till 4 o'clock, and on Morning of Sale.
NOTE.—For particulars of other Government Property for Sale, see *Surplus*, price 3d. at all bookstalls; or by quarterly subscription of 2s. post free in the United Kingdom, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W.1. H 297

UNIQUE OPPORTUNITY FOR THE DEVELOPMENT OF HYDRO-ELECTRIC POWER.

Messrs. J. A. Lumley and
DOWELL will SELL by AUCTION the Attractive, Residential, Sporting and Potentially VALUABLE ESTATE of BRAEMORE and FAIN, situated about twenty miles west of Garve, and about twelve miles from Ullapool, and close to the head of Loch Broom.
The BRAEMORE Estate lends itself in an almost unique degree to the development of Hydro-electric Power, a careful survey having been made, and no less than 10,000 brake horse power could be developed continually, the number of B. O. T. Units generated per annum being 87,000,000, and when completed the works would not interfere with the amenities of the Sporting Estate which is renowned for its 2nd Deer Stalking, and yields 100 Stags each season.
The magnificent and very complete Mansion House stands at 700 ft. above sea level, commanding magnificent views of the wildest Highland scenery. There is Salmon Fishing on the River Broom, as well as very good Trout Fishing on several Lochs.
Also valuable Timber in a ripe condition.
Full particulars may be had from Messrs. J. A. LUMLEY & DOWELL, who will offer for sale by AUCTION the above Estate at Winchester House, Room No. 37, Old Broad Street, London, E.C. 2, on Wednesday, the 21st day of July, at 2.30 p.m., prompt (unless sold previously by Private Treaty).
Lumley House,
34, St. James's Street,
London, S.W.1. H 378

FOR SALE.

Freehold Engineering Factory
and PLANT FOR SALE, West London Suburb, within 10 miles Charing Cross on L. & N.W. Railway, 31,000 ft. Floor Area. Central Heating. Electric Light. Complete gas service. Offices. Strong floors, some concrete. Good modern tool room and general Engineering Plant. Gang of seven Power Presses, including Taylor & Challen size 4½ in. deep drawing press. Woodworking shop with Machinery. River wharf adjacent. Suitable for motor lamps, side cars or similar purposes. Freehold for Sale, with any part of Plant required. Vacant possession.—ASHLEY, GORDON & CO., 100, Jermyn St., S.W. 1. H 386

For Sale, Vertical Hydraulic
PRESS, working pressure, 6000 lbs. per square inch, ram 23 in. dia. by 6 ft. stroke, four columns, 8 in. dia. by 2 ft. 4 in. centres, with moving table 3 ft. 3 in. by 3 ft. 3 in. and valves, and a
HYDRAULIC INTENSIFIER for above press, from 1500 lbs. to 2 tons per square inch, low pressure solid ram, 25½ in. dia. by 9 ft. stroke, high pressure solid ram, 12½ in. dia. by 9 ft. stroke with fixed inverted high pressure cylinder, two columns, 8½ in. dia. by 4 ft. centres, by Davy Bros., Sheffield.—THE WELDLESS STEEL TUBE CO., LTD., Wednesfield, nr. Wolverhampton. H 403

For Sale, Rails, up to 1000
tons, new perfect Steel Flange Rails, 75 lbs. per yard, British standard pattern (which can always be repeated), and by arrangement cut to specified lengths. Fastenings from Stock, viz.:—Fishplates, Bolts and Nuts, Spikes, special Cast-Iron Chairs for Curves, Switches and Crossings, Main line Sleepers and Crossing Timbers, clean and creosoted, new or second hand. Quotations, carriage paid, on hearing quantity, station, etc.
BUTE WORKS SUPPLY CO., LTD.,
8, Cymric Buildings, Cardiff. H 413

For Sale, One 3 in. diam.
spindle HORIZONTAL BORING MACHINE, by Dickinson, rising table 4 ft. by 3 ft., four-speed cone drive, all motions self acting; a heavy powerful machine in excellent condition, cheap and for immediate sale.—MIDLAND MACHINERY CO., 108, Dale End, Birmingham. H 393

12 HP. Crossley Gas Engine
(old type).
TRAVELLING CRANE, 14/15 ft. span, 20 ft. rise, 4½ in. by 10 in. girders
30 in. Roots CUPOLA BLOWER, by Samuelson.
Second-hand COMPRESSED AIR MOTORS, 2 in., 3 in. and 4 in.
Foundry CHAINS and SLINGS.
C.I. PULLEYS, various sizes.
OFFERS WANTED.
HUNT & MITTON, LTD., Ozzells Street North, Birmingham. H 397

Surplus Machine Tools for
DISPOSAL:—
LATHES
10½ in., 9 in., 8½ in., 8 in., by Dean, Smith & Grace, etc.
TURRET LATHES. HACK SAW.
1¼ in. CAPSTAN, by Pratt & Whitney.
Automatic SCREWING MACHINES.
Large VERTICAL MILLER, by Wilkinson of Keighley.
Two Spindle MOULDING MACHINES, by T. Robinson & Son.

WEYBRIDGE MOTOR ENGINEERING CO., LTD.
Weybridge Road, Weybridge.

(Telephone: 550 Weybridge. Telegrams: Activity, Weybridge.)
Full details on application, or machines may be inspected at above address.

H 367

For Sale continued on page 156.

HEAD OFFICE AND WORKS:—
GAINSBOROUGH, ENGLAND.
LONDON OFFICE:—
3, London Wall Bldgs., E.C.2.

INDIAN DEPOTS:—
Calcutta, Bombay, Lahore, Madras.
CANADIAN DEPOT:—
Saskatoon, Sask.

MARSHALL SONS & Co. LTD.

ENGINEERS AND BOILER MAKERS

MANUFACTURERS OF
PORTABLE ENGINES
SIMPLE AND COMPOUND TYPES.
SIZES UP TO 40 N.HP.

UNSURPASSED FOR
HIGH-CLASS CONSTRUCTION
ECONOMICAL WORKING
AND DURABILITY.

B 2243

BRIGHT COMPRESSED
SHAFTING
ROUNDS. HEXAGONS. FLATS. SQUARES.
KIRKSTALL FORGE CO., LTD., NEAR LEEDS.
3674

SOLID TYRE.

THE CHOICE OF A SOLID TYRE.

MEN who study costs always choose Dunlop.

As their records *decided*, so do they *justify*, the choice.

TRADE MARK. 7969

DUNLOP RUBBER Co., Ltd.,
FOUNDERS OF THE PNEUMATIC TYRE INDUSTRY.
BIRMINGHAM.

DUNLOP SOLID RUBBER TYRE FITTING DEPOTS: Belfast, Birmingham, Bristol, Coventry, Dublin, Edinburgh, Glasgow, Leeds, Liverpool, London, Manchester, Newcastle-on-Tyne, Norwich, Nottingham.

Dunlop solid rubber tyres are obtainable from all leading motor dealers.

REDPATH BROWN & Co. Ltd.
STEEL CONSTRUCTIONAL ENGINEERS AND MERCHANTS.

EDINBURGH,
LONDON,
MANCHESTER,
GLASGOW,
NEWCASTLE,
MIDDLESBORO,
BIRMINGHAM,
BELFAST.

VARIED STOCKS.
IMMEDIATE DELIVERY.
7914

Technical Advice, Designs & Estimates Free on Application

25000 Tons in Stock *Registered Office* 2 St. Andrew's Square, EDINBURGH.

Printed for the Proprietors by HARRISON & SONS, at the Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martin-in-the-Fields, and Published by CHARLES ROBERT JOHNSON, at the Offices of ENGINEERING, 35 & 36, Bedford Street, in the Parish of St. Paul, Covent Garden, both in the County of Middlesex.—June 25th, 1920.